The FOUNDRY

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Cast Andirons Harmonize With Room Decorations

IN THE good old days when fireplaces were fireplaces, huge caverns in the great halls, where mighty logs burned merrily and haunches of venison were cooked to an unctuous brown, andirons occupied an important place. They supported the ends of the logs and kept them within reasonable bounds. They also supported the spits or revolving devices on which, in part or in whole, the various species of domestic and wild birds and animals were converted into toothsome delicacies. Gradually as modern and more convenient heating and cooking devices were introduced, the great open fireplaces were abandoned. Charm of the open fireplace still remains. It is found—reduced in size—in many homes where it is regarded as a luxury and no longer as a necessity. In keeping with the modern idea, andirons now are regarded as a highly ornamental adjunct to the open fire. Cast iron and cast bronze lend themselves readily to the construction of these attractive pieces of furniture. Architects and interior decorators realize their value in adding to the beauty and attractiveness of a room. Designers have given their creative faculties full play in presenting individual patterns to harmonize with any style of interior decoration.

Courtesy May Co., Cleveland

Equipment for the Fireplace Adds Individuality To a Beautiful Room

Find Where Castings Can Be Sold

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Iron-Lined Brake Drums Are Cast Centrifugally

Fuse Alloy Iron Lining to Steel in a New Casting Process Developed by Campbell, Wyant & Cannon Foundry Co.

PROGRESS and development in the automobile industry has led to the production of heavier passenger and commercial cars with more powerful engines capable of speeds up to 100 miles an hour. Even makers of low and moderate-priced cars have no hesitancy in proclaiming guaranteed speeds of 70 miles an hour. As the speeds and weights of cars increased, it was discovered that more effective braking capacity was needed to control such vehicles which are capable of considerable destruction if they cannot be stopped rapidly, and the 4-wheel brake came into use.

Almost every new development in the automobile threw a heavier load on the brakes until at present their work is double and treble that performed when 4-wheel braking was first introduced. The automotive engineering fraternity during the last three years, in addition to establishing standards of greater power and speeds in both classes of vehicles, has added other desirable features; foremost among these being the new operating control known as *free wheeling*. It is claimed the application of this development alone has placed an additional burden of 40 to 50 per cent extra work upon the brakes.

This trend to greater weight, power and speed of the moving unit increased, to a figure never before achieved, the inertia to be dealt with in meeting effectively the requirements of safety and traffic regulations of a most liberal nature in the matter of dependable, quick-acting brakes. Each stop under the present day conditions has become the emergency stop of the past.

Success of these engineering achievements was unquestioned until, in their perfecting, it was discovered that the additional grief to which the braking surfaces were subjected demanded the dissipation of a much greater volume of heat at increased temperature. Moreover, the

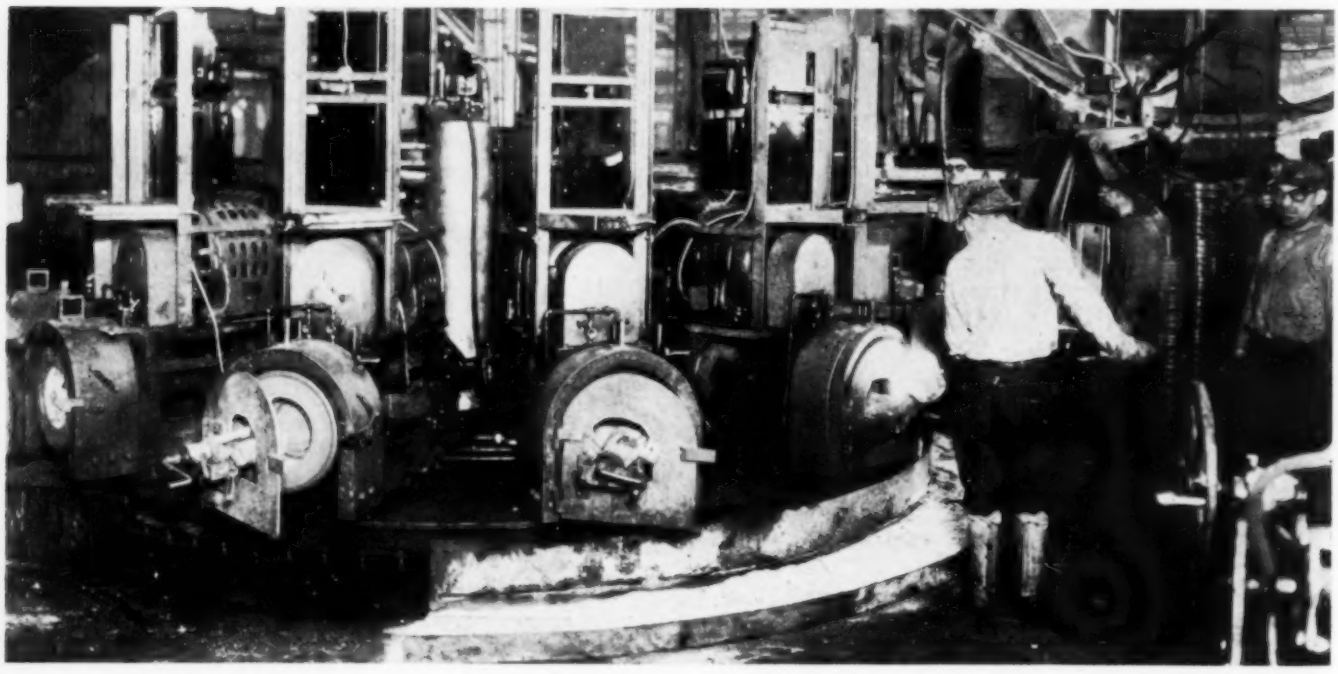


Fig. 1—A View of the Pouring Machine in Operation. At the Right a Pouring Basin Is Being Filled with Molten Metal from Hand Shanks

By

Edward W. Beach
and
Edwin Bremer

strength and texture to withstand this additional physical burden was not inherent in the commercial pressed steel brake drums of conventional design.

To offset the additional demands on the brakes, some improvements have been made in their design. Shape and application of the brake shoes have been changed, better and more durable linings, etc., have been provided, but the pressed steel drum practically has remained unchanged.

Pressed steel drums, which until recently have been used almost exclusively due to ease of fabrication, have recognized mechanical limitations. Under severe braking pressure and overheating caused by the braking action, the drums are expanded out of round causing eccentricity, bell-mouthing, barrel-shaping, scoring, etc. Under such conditions the actual braking surface subjected to the shoe pressure is considerably reduced with a resulting loss of braking action.

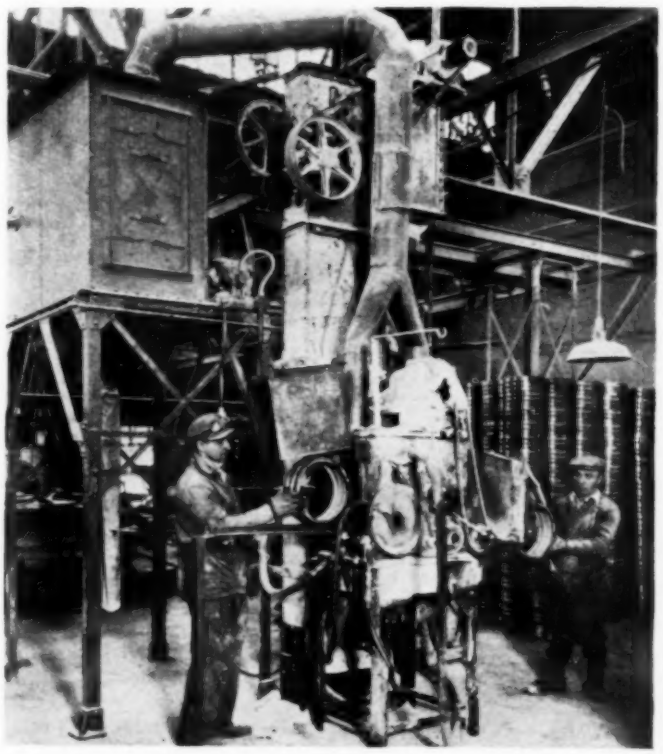


Fig. 2—Before Being Placed in the Production Line, the Drums Are Sandblasted on the Inside

Fig. 3—The Alloy Iron Used for Lining the Shells Is Duplexed in an Electric Furnace

It was natural that engineers turned to and experimented with gray iron and its alloys as the answer to this new problem, for the estalished and proven suitability of this material was unquestioned. In fact, entire brake drum units of cast iron have been in use successfully for several years on the heavier types of trucks and tractors. Many varying designs of integral castings and many mechanically attached cast brake drum liners within steel shells or holders have been given a trial.

With these facts in mind, and realizing that speed is dependent upon corresponding stopping ability, D. J. Campbell, president, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., several years ago began an intensive search for a suitable alloyed cast iron and process of manufacture for brake drums which would be light, dissipate the heat of braking friction rapidly, remain constant in dimensions and free from scoring, have a long life, and above all be safe and dependable in operation.

Complete Bond Necessary

His greatest problem was to retain the lightness and graceful lines of the pressed steel drums and embrace the mechanical efficiency of the desired and proven qualities of the cast iron braking surface. Innumerable tests, both in the laboratory and in service, showed that unless a complete bond between the steel drum and the lining was obtained, dissipation of heat developed by braking action was not uniform nor rapid, which caused unequal expansion between drum and lining and resulted in the buckling of the lining, and other difficulties.

Early experimentation showed that even though it were practical to heat the steel drums to a desired temperature and place it in either a dry sand or permanent metal mold, the steel stamping would lose sufficient heat so that when

Fig. 4—The Incandescent, Lined Brake Is Removed from the Chuck with a Special Hand Tool

the cast iron alloy was introduced into the mold it would not unite with the steel. Perforations in the steel shell failed to serve for interlocking purposes. Introduction of nonferrous metal anchors to cause a segregated brazing was ineffective, and the forming of the steel shell itself into various shapes to serve as a secure holder failed to approach the result sought for; the complete amalgamation of the two elements.

Experiments which lead far afield from the direct results desired were conducted by Mr. Campbell until he conceived the idea of spinning the heated steel band at high speed and introducing the molten metal at a temperature which would, in combination with an accurately predetermined temperature of the steel band, accomplish the actual fusing of the elements.

Experimental steel drums of various shapes and weights were fastened to a face plate on a crudely constructed spinning head for the purpose of trying out the idea of amalgamating the two metals by *fusing in* the alloyed lining by centrifugal force in combination with correct temperatures. The results obtained by this radical departure from accepted foundry methods gave promise of successful final results.

Make Exacting Tests

With the fact established that complete amalgamation could be effected and the elements united in actual fusion, the experimental drums thus made were subjected to the most elaborate and exacting mechanical and physical tests in the laboratory and on the road in actual service both on passenger and commercial vehicles of all sizes, weights and horsepower. These tests proved, without doubt, the value of this new idea.

With the assurance of the mechani-

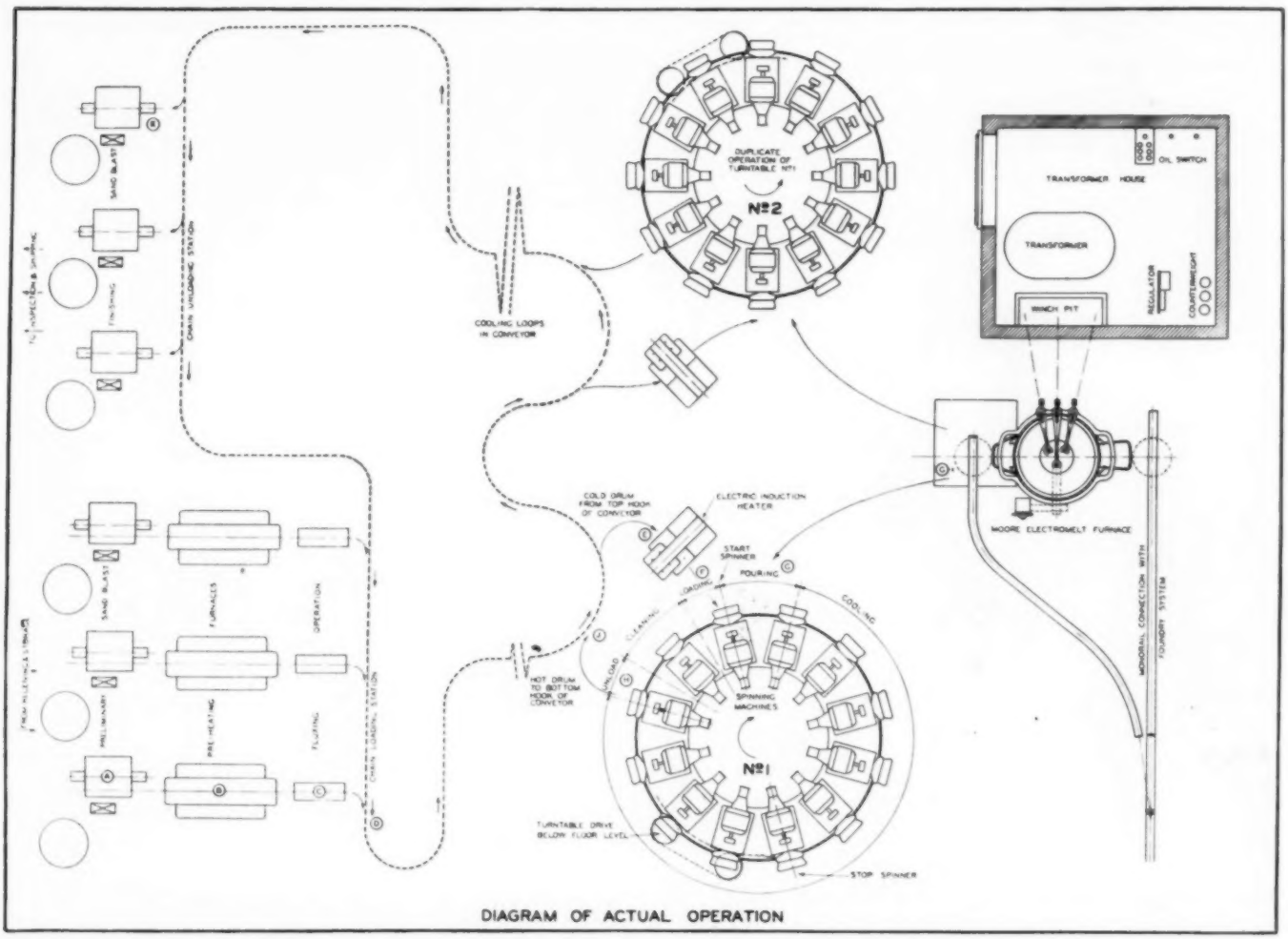


Fig. 5—A Diagrammatic Representation of the Manufacturing Process from Start to Finish

cal success of the product from the automotive engineering standpoint, the task of perfecting fast and accurate production methods was undertaken. This required the design of high speed centrifugal casting machines wherein a double-width steel band (which when cut in the center formed two duplicate, individual brake drum rings) could be *chucked* securely and accurately and revolved at high speed during the pouring or introduction of the molten cast iron alloy.

Next in importance was the assembly of these individual producing machines into production units and for that purpose the utility of the turntable method was chosen whereby the performance of the same operation by an individual operator could be utilized both for perfecting skill in operation and increasing production.

Units Are Compact

Space limitations required as compact a casting unit as possible. How this feature was attained is amply depicted by the accompanying illustrations and the statement that 12 centrifugal casting machines are mounted radially on a 15-foot diameter turntable which contains all the operating mechanisms, water and oil cooling systems, etc. View of the tables with the machines are shown in Figs. 1, 4 and 6. The same space limitations made it necessary to construct an elaborate overhead chain conveyor system 450 feet long which is located mainly in the trusses supporting the roof. It may be well before giving a detailed description of the method of producing the centrifugally lined steel bands, which are converted into the finished product under the trade name of *Centrifuse* brake drums, by Motor Wheel Corp., of Lansing, Mich., to outline briefly the procedure from start to finish. The production flow sheet is presented in Fig. 5.

The drums, which are electrically welded hooped circles of strip steel, are received at one side of the building in carload lots. They are cleaned on the interior portion only by specially designed sandblast units. One of the cleaning units is shown in Fig. 2. The cleaned drums are placed in a special device which gives them an interior coating of fluid flux.

Then they are suspended on chain hooks which carry the drums to the electric induction type preheaters at the opposite end of the building. An operator on the chain delivery side of the heater removes a drum from the conveyor hook and places it in the preheater. When the desired temperature is attained, an operator on the opposite side of the heater removes the hot drum, and places it in the chuck of the centrifugal casting machine as shown in Fig. 6.

The safety door containing the pouring ladle is closed after the chuck is locked in the closed position. The rotating mechanism is then started, and the pouring basin which has been filled with molten metal as indicated in Fig. 1 is immediately emptied into the rapidly rotating drum. As soon as the molten metal has solidified, the safety door is opened and the rotation on the chuck stopped. An operator removes the incandescent lined drum with a long fork as shown in Fig. 4 and places it on the lower hook of the conveyor chain for transportation to the cleaning and shipping departments. In the cleaning department the drums are sandblasted inside and outside in a machine deised especially by the firm's engineers for that purpose.

The turntable units are provided with space for 12 spinning machines and are approximately 18 feet in diameter overall. In the center of each table the water cooling system pump and radiator, the oil pumps, pressure tank, and oil filter for the hydraulic chuck operation and lubricating system are mounted. Each system has its reservoir tank below the surface of the table.

In addition, two intricate piping sytems and the conduits containing the electrical power circuits are placed in the center. The hydraulic system includes sight gages, dial gages, and an electrical pressure regulator which operates a by-pass valve for maximum high pressure and an electrical alarm gong for a minimum pressure, both of which are added as extreme safety measures in connection with the operation of the chucks.

The electrical power is taken from above by trolley and supplies twelve 10-horsepower motors and the operating motors of the oil, water and cooling systems. Drive for the turntable is located below the floor level and has incorporated in it a variable speed transmission which will permit of varying peripheral speeds from one revolution in 2 minutes to a minimum speed of 6 minutes for a complete cycle. The normal speed at which these tables are operated is one revolution in 3 minutes, or the passing of four chucks per minute past a given machine operation.

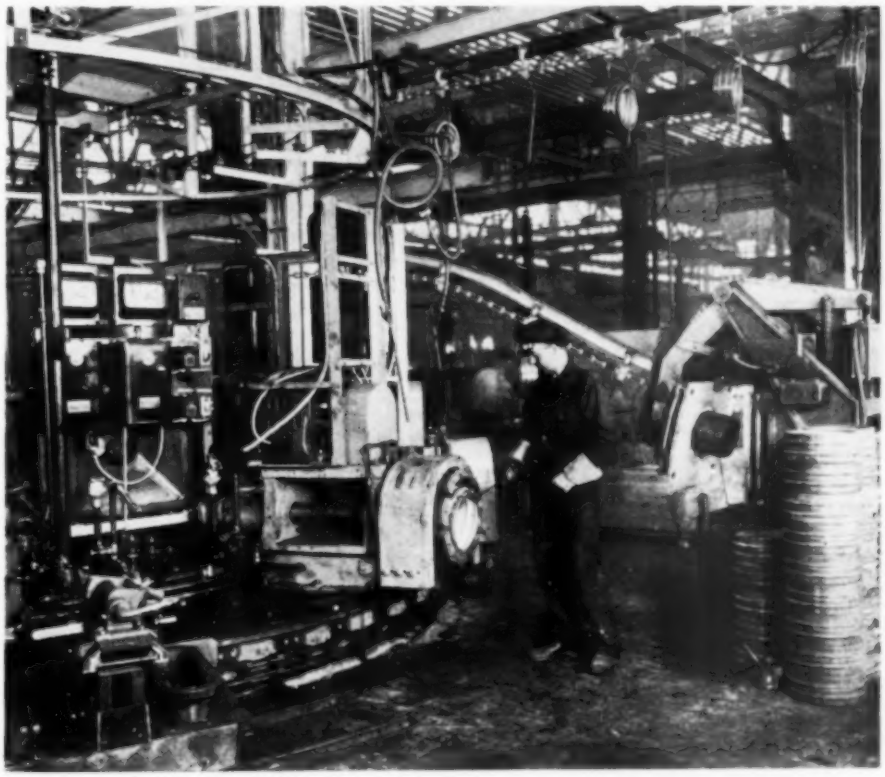


Fig. 6—Placing the Preheated, Incandescent Drum in the Spinner Chuck

The spinning or chucking machines, as may be observed from Figs. 1, 4 and 6, are extremely rugged in design and the spinning heads and shafts are balanced dynamically with the utmost accuracy to eliminate vibration of the chuck spindle, which is mounted on ball bearings. The outer race of the bearings is 12 inches in diameter carrying 2-inch balls and because of the extreme heat conditions to which these bearings are subjected, they are mounted in water cooled cases and served with forced feed lubrication.

The chuck is of the conical collet type operated hydraulically (oil) in both directions, that is, to open for receiving and ejecting the drum before and after casting, and for holding the drum securely during the initial cooling after the molten metal

(*Concluded on Page* 35)

Detroit Selected for A. F. A. Annual Convention

Technical Sessions, Shop Courses and Committee Meetings Feature Three Day Session. Philadelphia Show Will Be Held in 1933

DECISION of the American Foundrymen's association to hold a convention at the Hotel Statler, Detroit, May 3, 4 and 5, 1932 is announced by the executive officers in transmitting notice of action by the board of directors indicated on this page. When it was found desirable to defer the exhibition until the spring of 1933, Detroit was selected as the convention city. There the annual technical and business sessions, combining meetings, group discussions, round table and short course activities will be carried through on the announced week.

This action retains for the American Foundrymen's association the exceptional facilities of the new Philadelphia convention hall for the exposition next spring and by centering the convention this year in Detroit, provides accessibility for a greater number of foundrymen within overnight travel distance.

Detroit, recognized as the world center of automobile manufacture, is among the leading cities of the country in foundry activities.

From the time when the second meeting of the American Foundrymen's association, in 1897 was attracted to the city, the industry has profited directly and indirectly by the accomplishments of Detroit foundrymen and their leadership in the technique of castings manufacture. In the old days of demarcation between the only two main divisions, namely stove plate and machinery shops, through the development in all branches of castings manufacture, the foundrymen of the Detroit district have pioneered and freely shared in advancing the foundry art.

Announcement

THE board of directors of the American Foundrymen's association announces that the next annual convention of the association will be held at the Hotel Statler, Detroit, May 3, 4 and 5, 1932.

This announcement supersedes previous information that the annual convention and exposition would be held in Philadelphia on the same dates. The meeting at Detroit will be similar in character to the very successful technical meeting held at the Edgewater Beach hotel in Chicago in 1927, and will be the second annual meeting since 1905 held without a commercial exhibit being staged.

It is expected that all allied associations that contemplated meeting in Philadelphia will join the A. F. A. in Detroit, reserving as does the American Foundrymen's association, the splendid facilities offered by the new convention hall in Philadelphia for the spring of 1933.

The choice of the city as the locale for the annual meeting of the A. F. A. in 1932 is particularly opportune, in line with the reconstruction underway in industry. The courage and enterprise of manufacturers of Detroit inspires confidence. That this feeling of confidence is justified is evidenced by the advances in methods of manufacture, the development along metallurgical lines, and the regaining and extension of uses of cast metals recently announced or now under way in the foundry and allied industries of the region.

Shortening the scheduled time for sessions assures a full program for those attending the 1932 convention. The preliminary and tentative plan announced for Philadelphia contemplated close allotment of time to the various meetings, group discussions and shop courses extending from Tuesday until Friday inclusive. By condensing these activities into Tuesday, Wednesday and Thursday, May 3 to 5 inclusive, a full schedule is assured for all those participating. Further, meetings of other groups identified with the foundry industry or allied with the interests of castings manufacture are contemplated.

The shop operation courses which have proved to be an important contribution of the American Foundrymen's association to the education and progress of individual foundrymen will interest a great number of

operating men of the district. Further, their participation in the discussion will increase the value of these courses through the interchange of experience and knowledge on an intimate basis.

In addition to the technical sessions and the shop operation courses, the program for the three day session will include round table discussions of important technical problems and meetings of many of the association's committees. The officers of the A. F. A. are at work recasting the program to feature its most valuable contributions to the service of the industry and complete details will be presented in the April issue of THE FOUNDRY.

The last previous convention of the American Foundrymen's association held in Detroit was in the fall of 1926. At that time, the second International Congress of foundrymen brought to the city an attendance from throughout America and more than 100 delegates from overseas. Activities were centered at the fair grounds where an extensive and varied exhibit and all technical sessions were held. On that occasion, the Detroit Foundrymen's association organized a group of leading Michigan foundrymen who had charge of local arrangements, under chairmanship of of the late Robert Crawford. The Detroit Foundrymen's association is one of the largest and most active local groups and at present is officered by James L. Mahon, American Car and Foundry Co., president and Neil I. McArthur, Great Lakes Foundry Sand Co., secretary.

The Detroit association has appointed two committees to co-operate with the A. F. A. in arranging the convention. The personnel of the committees is as follows:

RECEPTION COMMITTEE—William J. Muhlitner, Great Lakes Foundry Sand Co., James L. Mahon, American Car & Foundry Co., S. Wells Utley, Detroit Steel Castings Co., Fred Erb., Eaton-Erb Foundry Co., W. H. J. Cluff, Frederic B. Stevens Inc., Vaughan Reid, City Pattern Works, Jesse D. Stoddard, Detroit Testing Laboratory, Hutton H. Haley, American Foundry Equipment Co., Kurt C. Babo, Dodge Brothers, J. C. Woodison, E. J. Woodison Co., Clarence H. Miller, Standard Pattern Works.

PLANT VISITATION COMMITTEE—Russell M. Scott, Packard Motor Car Co., John W. Collins, U. S. Aluminum Co., Hugh Martin, Detroit Gray Iron Foundry Co., William B. Crawford, Atlas Foundry Co., Harry Rayner, Dodge Brothers, Fred J. Walls, Wilson Foundry & Machine Co., John A. Moore, Acme Foundry Co., Harry W. Dietert, U. S. Radiator Corp., Matt P. Drennan, Sand Products Corp., Leslie G. Korte, Riley Stoker Corp., Elton T. Rogers, Sandwich Foundry Ltd.

Detroit Boasts of Many new Architectural Giants Embodying All that Is Modern in Beauty and Utility. The Building in the Center Decorated With Flags Is the City Hall, Once a Peak, but now a Valley Surrounded by a New Generation of Skyscrapers

Steel Brake Shell Has Iron Lining

(*Concluded from Page* 33)

has been introduced. During this period of cooling, the chuck must be held from opening against centrifugal force, notwithstanding that a safety lock is also provided to prevent operation of the control valv during this period.

The spinning machines are self contained to facilitate their handling on and off the turntable units. This is accomplished by the breaking of six pipe unions, the pulling of one electrical plug and the removal of six holding-down bolts; a special lift truck skid with a roller conveyor top of the same height as the turntable surface has been provided to facilitate the handling of casting machines.

This is the first of a series of three article describing the equipment and manufacturing process employed by the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., in producing alloy iron lined brake drums. Mr. Beach is engineering executive of the Campbell, Wyant & Cannon Co. and Mr. Bremer is metallurgical editor, THE FOUNDRY. THE EDITORS

Quad City Group Meets

Donald J. Reese, foundry engineer, Whiting Corp., Harvey, Ill., discussed the operation and salient features of the rotary type powdered fuel melting furnace before the regular monthly meeting of the Quad-City Foundrymen's association, held Feb. 15 at the LeClaire hotel, Moline, Ill. Mr. Reese's talk was followed by a motion picture showing the furnace in operation.

A. D. Matheson, chairman of the membership committee, Quad-City Foundrymen's association, spoke briefly upon the work of his committee, and John Ploehn called attention to the apprenticeship contest which is being conducted in connection with the convention of the American Foundrymen's association. Over one hundred attended the meeting including visitors from Freeport, Peoria, and St. Louis.

A total of 119,344 automobiles were produced in January compared with 121,541 units in December, according to a report of the department of commerce. Of the January total, 98,706 represents passenger cars, 20,541 trucks and 97 taxicabs. Canadian production in January was 3731 cars.

Discusses Manufacture of

Titanium Aluminum Bronze

Extensive Search for Suitable Degasifier Led to the Use of Titanium, Calcium and Magnesium in the Bronze

By Charles Vickers

TITANIUM aluminum bronze is a modern alloy of copper, iron and aluminum and contains only traces of titanium. The latter is added as one constituent of a special alloy used for its effect in removing gases, and improving the general casting qualities of the bronze. Titanium aluminum bronze was developed toward the close of 1916.

The content of titanium in these bronzes, for they comprise a series of alloys, is not sufficient to affect materially their physical properties, as only traces can be found in the bronze itself. Its presence in the treating alloy appeared to have a brightening effect on the surface coloring of the skin of the castings, as they came from the sand molds, which added to their saleability. Also, it justified the name titanium aluminum bronze given to the alloy, which was distinctive and valuable from an advertising standpoint.

Responsible for Discovery

The treating alloy, known as aluminum bronze degasifier, was formulated before the bronze itself, and was directly responsible for the discovery of the valuable properties conferred by the addition of iron to aluminum bronze. The degasifier was built by direct experiment with the hope of finding a treating alloy, which could be used in aluminum bronze with results similar to those of phosphorus in the case of the red brasses and the bronzes.

More particularly the work was carried on to reduce the drossing, selective shrinkage, and gas produced cavities that often are so distressing to the manufacturer of aluminum bronze castings. While that hope was realized only partially, the investigation to discover such a treating alloy proved an expensive proposition. However, it was neither time nor money wasted, as the difficulties encountered naturally led to research work to determine the reasons for such difficulties. Consequently, the investigation led to the development of an entire series of new alloys, and a knowledge of many of their properties.

Cured Worm Holes

IN THE early days of aluminum bronze considerable trouble was encountered with worm holes. That led to investigations to discover a degasifier which would give results similar to those obtained by the use of phosphorus in bronze and brass. After numerous experiments with a number of elements, a suitable combination was developed which gave good results. Titanium was one of the components, and led to the sale of the castings under the name titanium aluminum bronze.

Make Many Adjustments

In the evolution of that degasifying alloy numerous elements had to be examined singly, and in combination. The proportions of each had to be adjusted time and again, and the results of such adjustments determined by analyses, and from cast tensile test specimens. At that time the advantages of the ternary alloy of iron, aluminum, and copper were not known. The bronze used in the experiments contained 89.50 per cent copper and 10.50 per cent aluminum, which, as is well known, is superior to the 90 per cent copper, 10 per cent aluminum bronze.

The 10½ per cent aluminum bronze was the alloy specified by the

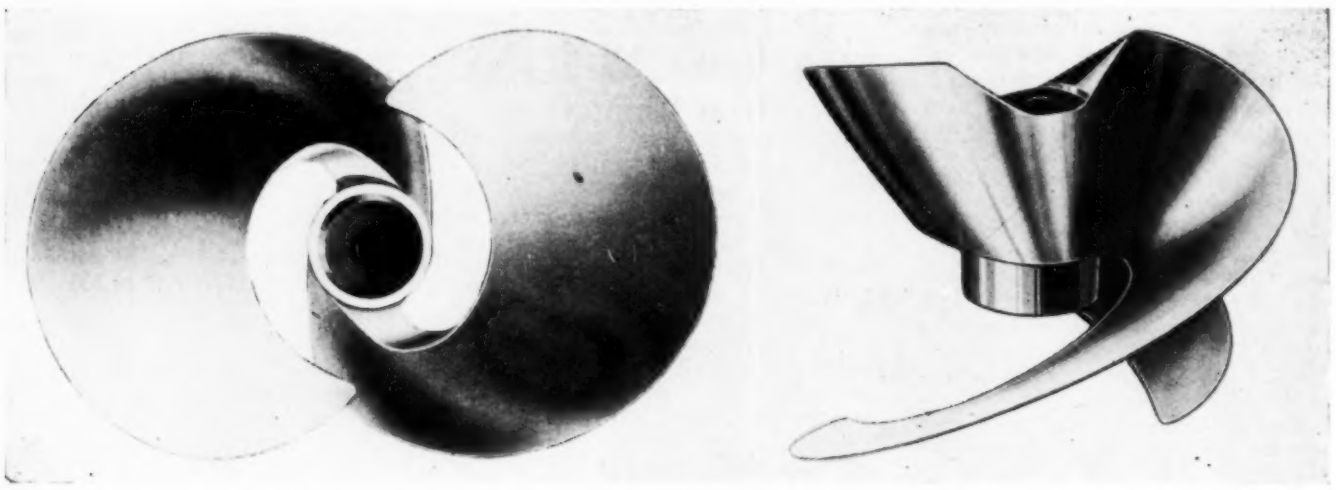


Fig. 1—A Pressure Die Cast Impeller for an Electric Dish Washing Machine. Fig. 2—A Side View of the Impeller Shown in Fig. 1 Illustrates the Thin Sections of the Blades

United States government to be used for the firing pins on the old Springfield rifle, as described by the late Erwin S. Sperry in *Brass World*, April, 1905. In his description Sperry mentions the government specifications as being for "aluminum bronze, Special Grade not less than 95,000 pounds per square inch tensile strength; cannot be forged cold." No other requirement is given.

Meets Specifications

The tensile strength was determined after the pin was forged, and no difficulty was found in meeting the specifications if the work was done with care. That particular formula was developed after much experimental work. The 11 per cent aluminum bronze was too brittle, and the 10 per cent bronze too soft. Also it would upset. The 10½ per cent bronze was exactly right. To obtain good results in making that bronze, Sperry states, the following points must be considered carefully:

Use only the purest copper and aluminum. Casting copper will not answer, as the pins made from it will not stand the test to which they are subjected. Melt the aluminum bronze twice. Keep the aluminum in the mixture at exactly 10½ per cent. Do not overheat the metal or allow it to soak in the fire and pour at as low a temperature as will insure that the metal will fill the mold. Use no flux, phosphorus, manganese, zinc, or tin in the mixture; only copper and aluminum. Keep the sand as dry as it can be worked, and do not ram it too hard.

These precautions are mentioned here because with slight changes they are just as applicable today as when they were written. The firing pins were round rods about 4 inches long and ¼-inch in diameter, and they were always made of aluminum bronze for the Springfield rifle, because steel would not stand up. That, no doubt, was before the days of alloy steels.

That was the aluminum bronze we selected, and hoped to improve by adding a special alloy to treat it, and eliminate the various foundry troubles invariably encountered.

In addition to the titanium previously mentioned, the treating alloy also ultimately contained manganese, calcium and magnesium. The calcium and magnesium were the more active elements; the titanium and manganese being relatively unimportant. The four elements were dissolved in a base alloy of copper and aluminum, in such proportions that they formed a brittle alloy that could be broken easily into small fragments necessary for making the weights for addition to the bronze.

Add Small Amounts

One half of one per cent was the usual addition made to aluminum bronze on its first melt. In the case of remelted metal that had been previously treated, one-fourth of one per cent of the degasifier was added. The small amount usually was sufficient to improve the bronze materially, and nothing could be gained by using a larger amount, although occasionally in the case of die castings as much as one per cent was added to the alloy.

A typical analysis of the impurities added to the bronze by an addition of 0.5 per cent of the *degasifier*, as it was named, when first made, follows:

No.	Calcium Per Cent	Magnesium Per Cent	Titanium Per Cent	Manganese Per Cent
A	0.014	Trace	0.017	0.084
B	0.011	Trace	0.011	0.060
C	0.003	Trace	0.003	0.072
D	0.007	Trace	0.008	0.019
E	0.006	Trace	0.003	0.109
F	0.003	Trace	0.013	0.072

The remainder of the alloy was copper, aluminum and a small trace of iron carried by the titanium copper.

Outlines the Method

The formula for the degasifying alloy was built up as follows: First; alloys were made and treated with varying amounts of calcium, the latter being added as an alloy with copper, zinc, aluminum and in the metallic form.

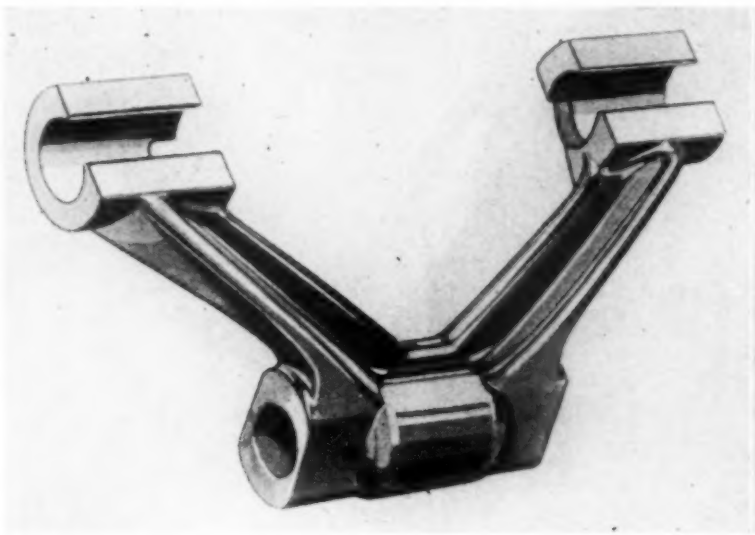
Magnesium also was tried in the same manner and it was found that considerably more magnesium than calcium could be added to aluminum bronze, without greatly injuring the alloy. Magnesium hardens aluminum bronze. Its influence on copper alloys is understood and therefore it will not be necessary to give a lengthy report of the work done with that element in aluminum bronze.

However, the following alloy was made with many others having higher proportions of magnesium: Copper 89.75 per cent; aluminum 10.00 per cent; and 0.25 per cent of 10 per cent magnesium-copper. The castings came out of the sand bright with

Table I

Physical Properties of the Test Specimens

Elastic limit, pounds per square inch	18,600	18,300	26,500	22,600
Ultimate strength, pounds per square inch	76,300	77,100	74,200	74,600
Elongation, per cent in 2 inches	26.0	27.5	23.0	27.0
Reduction of area, per cent	24.8	29.8	27.5	29.9



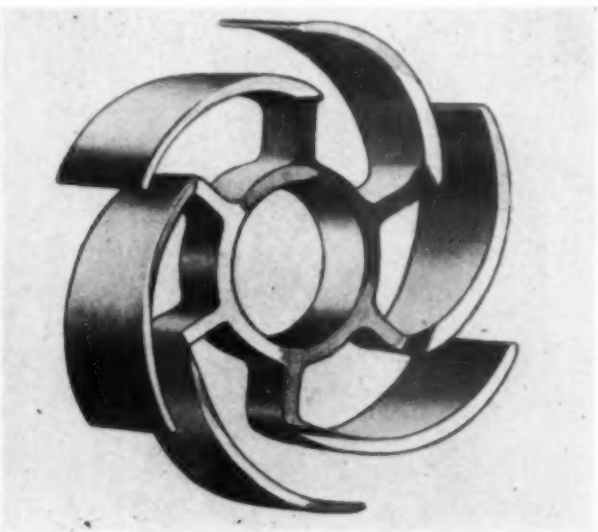


Fig. 3—Die Cast Roller Yoke Bracket for a Variable Speed Transmission. Fig. 4—A Centrifugal Pump Rotor for an Electrical Dish Washing Machine

purple hues predominating. The colors were variegated, the fracture of the test bars appeared crystalline, and a large gas cavity was present in the center. The effect of a small amount of magnesium was quite noticeable.

The influence of manganese on aluminum bronze is not at all harmful. It can be added in any amount and it appears to increase the elongation, and decrease to some extent the tendency of the alloy to cast with holes. Therefore it was thought best to select manganese as one constituent of the treating alloy. In one test of 10 per cent aluminum bronze with 0.3 per cent manganese added, the following results were obtained: Ultimate strength, 63,800 pounds per square inch; yield point, 19,700 pounds per square inch; elongation, 49.3 per cent in 2 inches, and reduction of area, 42.1 per cent.

Manganese Is Used

At least two patents have been issued in the United States for the use of manganese in aluminum bronze, and many claims have been made as to the value of such additions. However, as far as the casting difficulties are concerned, the influence of manganese seems to be nil. It is just as difficult to make castings of aluminum bronze containing a small amount of manganese, as it is without that assistance.

Experiments with manganese in aluminum bronze have extended over a period of years. In some alloys it appears to increase the tensile as will be shown later, but it also has a tendency, when present in amounts over 2 per cent, to affect the liquidity of the bronze flowing into the mold, so that hair cracks are prevalent. The latter, in the case of cast to size test bars, injuriously affects the value of the tests. The small amount of manganese introduced by the degasifier is beneficial, rather than harmful.

One of the early patents covering the addition of manganese to aluminum bronze is that of John A. Jeancon, Newport, Ky. Jeancon claimed an alloy of copper, aluminum and manganese in about the proportions of 75 to 85 per cent copper, 12 to 25 per cent aluminum, and 2 to 5 per cent manganese. In making his alloy Jeancon preferred first to make a basic alloy of manganese aluminum as follows: Fifteen pounds of anhydrous postassium and calcium chlorides first were charged into a graphite crucible. That was heated slightly and a quantity of comminuted carbon stirred in. Next 15 pounds of aluminum in small fragments were added which was heated to a cherry red. The inventor stated this fused the chlorides, and softened the aluminum. (One would think it would melt the aluminum also). Lastly 15 pounds of anhydrous manganese was added, the crucible covered and heated to whiteness.

The resulting regulus consisted of aggregations of nodules of varying proportions of the metals, which then were lixiviated in boiling water to remove the soluble salts. The metal or regulus as it was called was remelted to bring it to uniform composition. Then the copper was melted and the proper proportion of the manganese-aluminum added to make the basic alloy. The losses in that process were estimated by Jeancon as 1 per cent aluminum, and from 8 to 10 per cent manganese chloride. The number of this patent is 446,351, Feb. 10,1891.

In the early formulas for the degasifying alloy, it was found as the work went on that the proportions of the more active elements were not adjusted properly; the tendency being to use too much of one and not enough of another. That resulted at first in getting widely varying results with the castings. A run of good castings continuing for several days would be followed by a period in which bad castings predominated. For example, two of three analyses gave good results and one provided extremely bad results as follows:

Element	No. 1-Good Per Cent	No. 2-Bad Per Cent	No. 3-Good Per Cent
Copper	47.76	51.60	54.51
Calcium	1.86	1.30	1.63
Magnesium	0.34	0.42	0.57
Manganese	4.17	4.40	4.65
Titanium	1.34	1.87	2.13
Iron	Trace	0.22	Trace
Aluminum	Remainder	Remainder	Remainder

The variation in compostion was not so great as to account for the widely different results obtained. Considering the three analyses given, it will be noted that the bad one contained 0.22 per cent iron, and the good ones merely traces. That appeared significant, so numerous heats of the degasifier were subjected to analysis, and it was found that all those giving bad results contained iron in some proportion. Thus, one with only 0.16 per cent gave discouraging results, and as a result of a lengthy investigation it was decided that iron was the harmful element.

Iron Always Present

However, it was found impractical to make an iron-free metal commercially, for that element was introduced into the degasifier by the titanium-copper used. Also in melting the copper, small additions of iron could not be avoided at all times. Therefore, the sensitiveness to iron, shown by worm holes in the treated castings, must be due to some other cause.

To demonstrate that the cause of such troubles was really iron, an alloy containing 89.50 per cent copper, and 10.50 per cent aluminum was made and treated with the flux as usual. Half of the heat was poured into sand castings which were sound

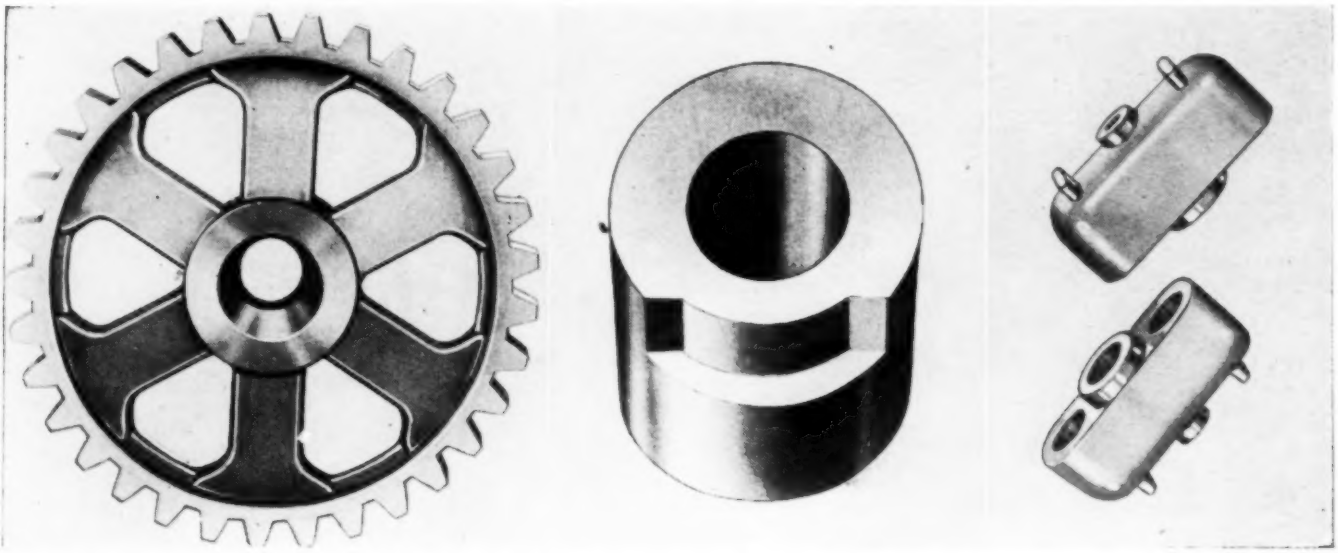


Fig. 5—A Pressure Die Cast Gear. Fig. 6—A Worm Gear Blank. Fig. 7—Two Views of Pressure Die Castings Which Are Cored. All Illustrations Show Fine Casting Surfaces

and good. The remaining half of the heat was remelted in the same crucible, and 1 per cent iron was added without further treatment of the alloy. These castings were full of worm holes and also were porous.

Degasifier Causes Trouble

The investigation with iron was continued and it was found that the use of aluminum containing over 0.30 per cent iron was likely to give poor results. When the degasifier was omitted the iron did no particular harm, so it followed that the former was at fault. The degasifier at that time was high in calcium and low in magnesium; containing between 1.75 per cent to 2.00 per cent calcium, and from 0.40 to 0.60 per cent magnesium. Also it was likely to segregate. It was thought these elements were not adjusted properly as there was no data to work on and the proportions were purely empirical.

Accordingly, a heat of the 10.5 per cent aluminum bronze was made and treated with 0.055 per cent calcium. The sand castings looked clean, but had a dull, uniform light brown color. The risers shrunk smoothly and on the surface had iridescent colors. Fractures of the test bars were fibrous, and small gas cavities showed in the center of the bars when broken. The effect of calcium on copper and aluminum mixtures appeared powerful, and the indications were that it must be used in homeopathic doses only. Otherwise it caused the difficulty its addition is expected to prevent.

The investigation now turned to magnesium in aluminum, and it was found that it had a hardening effect, and when high would make the bronze low in elongation, but it produced no porosity. Therefore, a trial heat of aluminum bronze containing 10 per cent aluminum was made, and treated with 0.2 per cent magnesium and 0.2 per cent calcium. The result was a surprise, the sand made castings were peppered with small holes on the skin of the castings.

Increase Magnesium Content

Other tests made showed that when the magnesium overpowered the calcium, good results were obtained, so finally the treating alloy was changed so that the content of calcium was 1 per cent and that of magnesium from 2 to 2.25 per cent. The remainder of the alloy would contain about 2.75 per cent titanium; 6 per cent manganese; 44 per cent copper; 44 per cent aluminum. The alloy was melted twice to control segregation. For a considerable period of time, every heat of this degasifier was tested in an alloy of the following composition: 88.90 per cent copper; 0.60 per cent iron; 10.00 per cent aluminum, and 0.50 per cent degasifier. Cast to size test bars were made and pulled with the results shown in Table I.

No trouble was experienced when using the remodeled flux. The iron content evidently resulted in considerable improvement of the bronze. Therefore, a further investigation, this time with iron, was instituted, and the result was titanium aluminum bronze. The most widely used alloy was probably that which was christened No. 5 alloy. It contained 89 per cent copper, 10 per cent aluminum, and 1 per cent iron and still is used largely. Its physical properties in small castings are about the same as those presented in Table I.

It has been found that the alloys with higher iron, shrink a little more than the 1 per cent alloy, and for that reason, it is a favorite alloy for those foundries using the gravity die casting or permanent mold process. One firm, the Aurora Metal Co., Aurora, Ill., uses that alloy for pressure die castings, and in its advertising literature states that it is stronger than steel. It is claimed that pressure die castings made from the composition mentioned are highly resistant to corrosion, have remarkable shock resisting and wearing qualities, and show a tensile strength of approximately 85,000 pounds per square inch as cast.

By heating the castings to 1700 degrees Fahr, and quenching in water, the tensile strength may be increased to 100,000 pounds per square inch. In the cast state the hardness of the castings is 140 brinell or 66 rockwell B scale, and when quenched from 1700 degrees Fahr, the hardness is increased to 260 brinell or 110 rockwell B scale. Any desired hardness between those limits may be obtained by proper heat treatment. For example, by drawing at 1150 degrees Fahr. and quenching, a hardness of 165 brinell or 85 rockwell B scale may be obtained.

The effect of temperature on the strength of the pressure die cast alloy is shown by the following data given by the Aurora company:

Temperature Deg. Fahr.	Tensile Strength lbs./sq. in.
70	84,800
400	66,800
550	59,000
800	40,300
1000	19,000

Other characteristics of the alloy are: Melting point approximately 1950 degrees Fahr.; specific gravity, 7.6; electrical conductivity, 18.4 per cent of that of soft drawn copper, and coefficient of expansion, 0.000017--inch per degree Fahr.

To show what is being accomplished in pressure die casting the 89 per cent copper, 10 per cent aluminum, and 1 per cent iron alloy, the accompanying illustrations are presented. Fig. 1 shows a die cast impeller used in a dish washing machine, and Fig. 2 shows the uniformly thin sections and the smooth surfaces obtained on the blades through pressure casting. Thin sections as shown would be difficult to cast by the gravity process. Fig. 3 is a roller yoke bracket for a variable speed transmission which weighed 20 per cent less than the ordinary bronze casting previously used, and was considerably stronger .

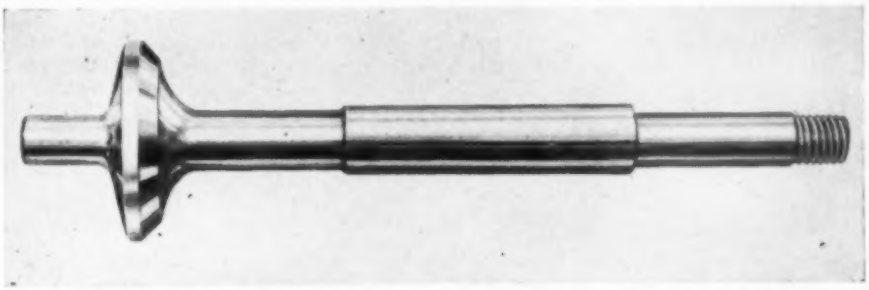


Fig. 8—Poppet Valve for a Locomotive Blow-off Valve Which Was Pressure Die Cast in Aluminum Bronze

Castings Are Chilled

In Fig. 4 a centrifugal pump rotor for a dish washing machine is illustrated, and Fig. 5 is a pressure die cast gear. Fig. 8 shows a poppet valve that is subjected to the corrosive effects of sludge and hot water, and withstands those conditions well. Fig. 6 is a worm gear blank, and Fig. 7 is an example of cored work. The 89 per cent copper, 10 per cent aluminum and 1 per cent iron alloy is at its best when made in the form of pressure or gravity die castings, for they are comparatively small, and are chilled rapidly which insures the highest physical values. Although all alloys of aluminum bronze treated with the degasifying alloy are entitled to the name titanium aluminum bronze, the 89-10-1 alloy usually is connected by many foundrymen to the designation titanium bronze or titanium aluminum bronze.

The treating alloy or degasifier containing 1 per cent calcium was standard for several years, but with a large output of bronze indications were that it was not quite perfect as now and then losses due to worm holes and other defects which it was supposed to eliminate, were encountered. Consequently, a further investigation of overhauling of the alloy was carried out which resulted in a change of composition. The new

formula became: 1.50 per cent titanium, 6.0 per cent manganese, 0.50 per cent calcium, 2.50 per cent magnesium, 26.50 per cent aluminum, and 63 per cent copper. Instead of melting the alloy twice, a new method was developed which saved a little time, and gave good results. That method, and several other variations of it will be described in the next article which also will contain some information on molding practice to be employed with aluminum bronze.

This is the first of two articles relating the origin and history of titanium aluminum bronze. The second will appear in an early issue.

—THE EDITORS

Operated for Nearly 100 Years

By P. D. Forbes

ONE of the most modern foundry plants in Scotland, the Coltness Iron Co., Newmains, Lanarkshire, has been operating for nearly 100 years near the historical town of Lanark, where according to all reports, Kenneth II held court nearly 1000 years ago in the year 978.

The company was organized in 1836 primarily for the production of pig iron and the site was chosen on account of its proximity to valuable deposits of coal and ironstone. The foundry was built first to produce castings for the company's own use in the blast furnace and mines. As more property was acquired the mining industry was expanded and the foundry was enlarged to take care of all the special castings required in winding engines, pumps, pipe lines, hoists and rolling stock. During normal periods the annual coal production is 2,000,000 tons.

By-product plants in connection with the furnaces were and are responsible for the production of a wide variety of castings. From making a few odd castings for outside customers, the business gradually has increased to a point where the Coltness company is one of the greatest producers in Great Britain of many lines of castings.

The original 5-ton open-hearth furnace long since has been replaced by two open-hearth furnaces, one of 25 and the other of 35 tons capacity. Steel also is melted in two 2-ton converters and one 3-ton electric furnace. The foundry is equipped to handle steel castings up to 25 tons and iron castings up to 50 tons in weight.

Up to 1876 the blast furnaces were operated with open tops. The territory for miles around was lighted at night by the escaping flames. In recent years the furnaces have kept pace with improvement in design and operation. About 30 years ago a use was found for blast furnace slag in the manufacture of cement. Since that time the mountains of slag, the accumulation of 70 years, have disappeared.

The company also makes fireclay enamel ware, road making material and fire brick.

Features Copper Alloys

V. P. Weaver, technical department, American Brass Co., Waterbury, Conn., addressed the regular meeting of the Connecticut Nonferrous Foundrymen's association, held at the Hotel Garde, New Haven, Conn., Feb. 8, on the subject "Copper and Its Alloys." The feature discussed in detail was the physical properties of many nonferrous alloys. As an added feature, W. S. Girvin, assistant metallurgist, American Brass Co., showed several reels of pictures entitled "Mine to Consumer."

C. H. Blanchard, Reading, Pratt & Cady Co., Hartford, Conn., and president of the association, presided. The next regular meeting of the group will be held on March 14 and will be addressed by Furman South Jr., Lava Crucible Co., Pittsburgh, on the subject of "Refractories."

Committee Meets

The publicity and educational committee of the Materials Handling institute, New York, held its first meeting in Detroit on Feb. 12. Plans were discussed and a definite program of educational work was outlined and acted upon of which details will be announced later. Members of the committee are John R. Booher, Cleveland Electric Tramrail division, Cleveland Crane & Engineering Co., Wickliffe, O., chairman; W. V. Casgrain, Mechanical Handling Systems, Detroit; W. C. Peak, Service Caster & Truck Co., Albion, Mich., and S. W. Gibb, Yale & Towne Co., Stamford, Conn.

Index of foundry equipment orders for January was 20.5 compared with 20.9 in December, according to a report of the Foundry Equipment Manufacturers association. Index of unfilled orders at the end of January was 29.1.

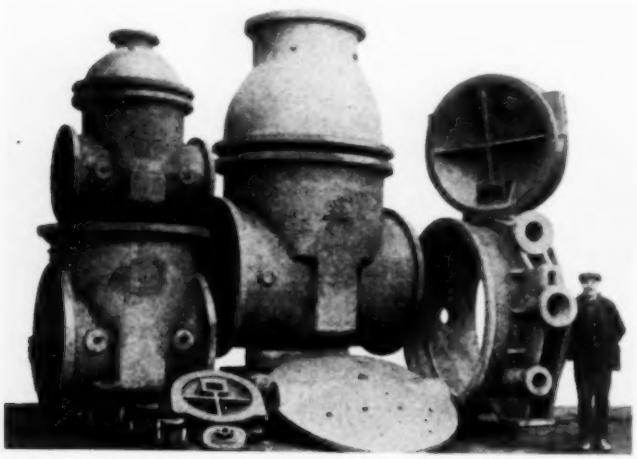


Fig. 1—Cast Steel Valve Castings Are Made in All Sizes. Fig. 2—The Coltness Co. Is One of the Largest Manufacturers in Great Britain of Steel Castings for Locomotives

Prevent Losses With Proper Gates and Risers

By Pat Dwyer

ON ACCOUNT of peculiarities inherent to the behavior of the metal when cast in sand molds, aluminum bronze castings, even those of simple shape, must be molded in a manner different from that employed with other nonferrous alloys.

Aluminum bronze creates dross and shrinks excessively. Where the creation of dross has been prevented and where proper measures have compensated for the shrinkage, an apparently perfect casting may disclose gas cavities, internal shrinkage cavities and little nests of a white metallic substance, alumina, during the machining operation.

Chill the Casting

In massive castings poured in sand molds, the metal changes during a slow cooling period and shows a disappointing drop in tensile strength and in elongation. This change, known as self annealing has to be prevented either by some device which chills the casting quickly, or by the use of special aluminum bronze alloys immune to the effects of slow cooling.

Radical difference in the gating methods employed on a plain aluminum bronze stick casting 3 inches diameter and 12 inches in length and the same casting in red brass, is shown in Fig. 151. With red brass or with any of the so called gun metal alloys, this casting readily could be made horizontally with a gate and riser at one or both ends. When one of these castings shrinks a depression will be found on the cope side. Where this depression has been prevented by a suitable riser, the casting may be accepted as sound and solid. With aluminum bronze a smooth, apparently perfect cylindrical body does not always indicate a solid casting. Cutting the casting into sections may reveal a large hole in the center.

A typical casting of this kind split longitudinally for examination is shown at *D* Fig. 149. A casting of this kind will result where the casting is gated at one end and fed through a riser at the other end. The defective section is shown in the center of the casting. The shape of this internal defect will depend on the manner in which the casting is fed. The shape shown in the illustration, tapering from the center toward both ends, is produced when the casting is fed from both ends, either from gates or risers.

Under certain conditions where the bar is used as a unit, a cavity in the center might not affect the casting adversely. However, castings of this kind usually are designed to be cut into smaller pieces and manifestly the casting must be solid and homogenous throughout. One method for overcoming shrinkage in aluminum bronze sticks is shown in Fig. 151.

In a second method illustrated in Fig. 149, *A* is a section of the mold longitudinally through the riser, gate and runner. *B* is a section of the same mold through the riser and *C* is a plan of the drag half of the mold. The riser and gates are located midway to feed the castings from the center. The riser is ½-inch larger in diameter than either of the castings it is designed to feed. Also it is several inches higher than would be necessary on similar castings in red brass.

The angle of connection between the gate and the riser is rounded as shown at *F* in Fig. 149. This method will prevent shrinkage defects, but it is not as infallible as the method shown in Fig. 151 for preventing inclusion of dross.

Use a Horn Gate

In Fig. 149 the sprue is located near the end of the flask for convenience in pouring and is connected to the base of the riser by a combination of straight runner and horn gate. While the use of a horn gate is not compulsory in all instances of this kind, it is advisable in many instances and is introduced here to illustrate one of the peculiar features in connection with aluminum bronze.

Ordinarily a horn gate is placed with the small end next the casting. With aluminum bronze this practice is reversed to avoid the jet or nozzle effect. With a gate passage constantly increasing in size, the speed of the metal stream decreases as it approaches the outlet, in this instance the base of the riser. When a horn gate is not employed, the runner passage from the sprue to the base of the riser should be cut on the same general pattern, that is gradually increased in size toward the riser end. As stated previously, any agitation in aluminum bronze creates dross. It may be compared to the lather on soapy water. This metallic lather becomes incorporated in the casting and usually is sufficient to spoil it.

Many large aluminum bronze castings, valve stems and shafting, are cast in the manner illustrated in Fig. 150. The sprue is zig-zagged from the top to the bottom of the mold and in cross section is a shallow half oval. On a repetition job the first sprue is cut in the joint of the drag with a gate cutter. Later, the metal in the sprue is removed from the casting, cleaned properly and used as a sprue pattern on subsequent castings. On account of the comparatively small section, the sprue easily

Show Many Gates

PECULIARITIES inherent to aluminum bronze, particularly while passing from the liquid to the solid state, involve many changes in the orthodox methods adopted for the production of castings in red brass alloys. The metal shrinks excessively and must be fed from risers which in many instances outweigh the actual metal in the casting. The least agitation of the metal produces dross or metallic scum, which may lodge at some point in the casting and create a defective area. Theories vary on the causes responsible for castings which leak when pressure is applied, but which appear normal on all other occasions. In many instances the blame for defective castings is laid at the door of the metal or the manner in which it is melted, when in reality the blame should be placed on the core.

is kept filled during the pouring process. The zig-zag shape carries the metal down gently and prevents the formation of dross in the casting.

Pour Casting Horizontally

On castings poured in a vertical position it is necessary to extend the casting beyond the required length to provide a sink head. The metal in this head feeds the casting and in so doing develops an internal cavity or pipe. The part containing the pipe is cut from the casting during the cleaning or the machining process.

The horizontal method as shown in Fig. 150 may be adopted to advantage on large castings 6 inches or more in diameter. The spiral type of sprue is applied through the medium of a dry sand core rammed in the cope and connected to a second core in the drag which conveys the metal to the lowest part of the mold without agitation. The sand in these runner cores is bonded with silicate of soda which does not burn out or give off volumes of offensive gas.

Usually the head must be carried higher than the top of the cope. To insure maximum feeding effect the head should be made up in a dry sand core. The pipe or cavity in an aluminum bronze head is greater than in other alloys, therefore the head must be built up higher than usual. For example, a 6-inch head will be required on a 10-inch cope. In pouring metal into a mold of this kind, pouring ceases when the metal appears in the bottom of the risers. The sprue is covered with sand and a weight is placed on the sand. In some instances it is possible to ram sand in the sprue opening. The object in both cases is the same, to plug the sprue so that the metal will not flow back through it when the ladle or crucible is shifted from the first position and a stream of metal is poured directly down into the riser. In this manner the hottest metal is placed where it is needed most urgently.

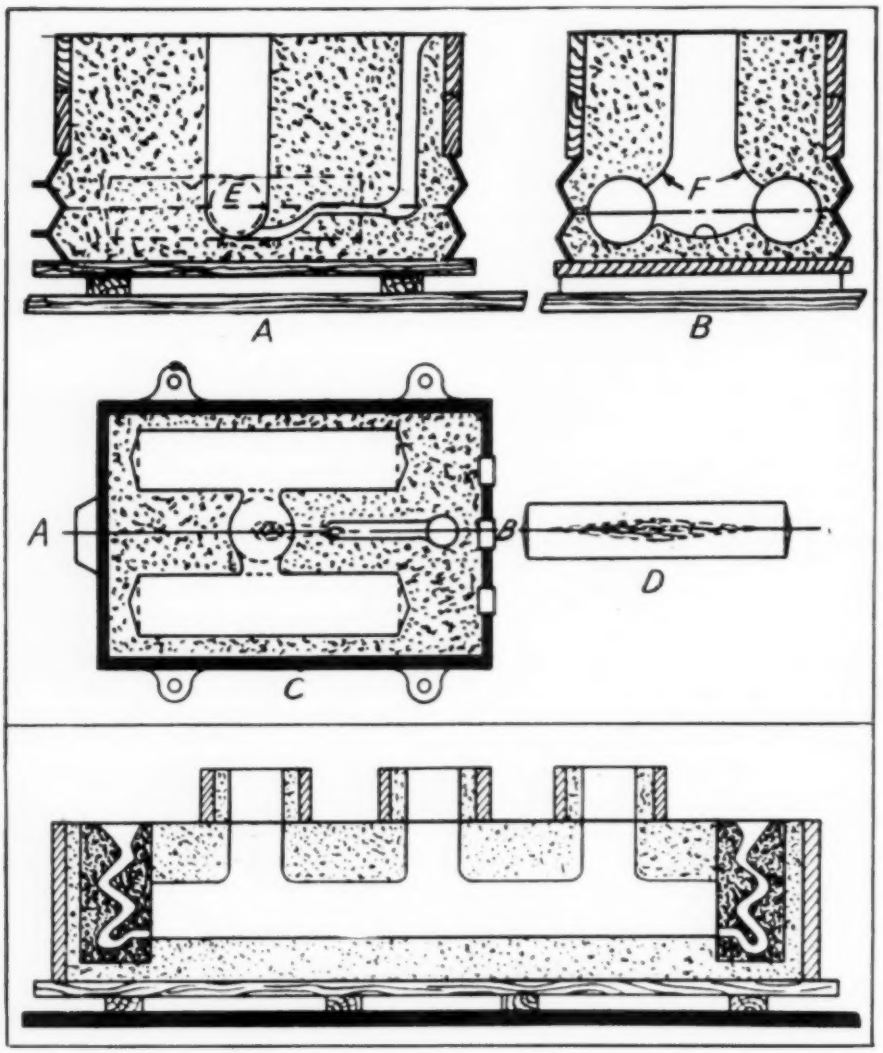


Fig. 149—(Above)—The Horn Gate Discharges First Into the Base of a Heavy Riser Which Afterwards Feeds the Castings. Fig. 150—(Below)—Alternative Method of Feeding a Long Casting from the Top and Pouring the Metal from Both Ends

Even with plain, simple castings poured from any of the various red brass alloys, difficulties are experienced in securing perfect castings. This peculiarity is not confined to large or intricate castings. It is found just as frequently among small castings where a considerable number of patterns are mounted on a plate for machine molding. The greatest mortality is found among castings destined to withstand steam, pneumatic or hydrostatic pressure.

Reference to an interesting method for preventing leakage and porosity on small castings of that kind was made in No. 19 of the present series, published in THE FOUNDRY Oct. 15, 1931. The method originally was described by W. H. Parry in a paper presented before the American Foundrymen's convention at Rochester, N. Y., June, 1922. The ingenious method of arranging the patterns and runners is worthy the attention of any person confronted with the problem of arranging patterns for anticipated large production. The basic principle involved, small gates and a high head, is recommended to all foundrymen whether engaged in the production of small or large castings in which density is an essential feature.

Time Out for Digression

A brief digression may be in order here to touch upon the causes of porosity and the manner in which the foregoing gating system prevents porosity of a certain kind. Porous castings may be divided into two general classes. Those in which the holes or porous areas are quite apparent to the naked eye, and those in which porosity only can be detected when the metal is subjected to the force exerted by gas or liquid under high pressure.

The obvious porosity, blowholes and gas holes caused by molding or melting practice, has been touched upon previously and without doubt, will come in for a share of discussion again, before this series of articles is brought to a close. For the present, consideration will be given only to intercrystaline porosity, the invisible kind, manifest only when gas or liquid pressure is exerted against the casting.

According to one theory, this form of porosity is caused by an expansion of the individual crystals of the metal, followed by a contraction during a later period of solidification. This expansion naturally would push each crystal away from its fellow. Subsequent contraction would open little passages between them.

The objection to this theory is that by the time the crystals in the heart of the metal thickness had formed, the skin of the casting would be solid and strong enough to resist any expansion of the surface that naturally would follow any expansion of the crystals. The result of this

would be an inner expansion that would push the crystals together, a compressive force that conceivably might distort the crystals.

Under the foregoing theoretical conditions, changing the gates would not affect the result. However, experience has shown that the gating method is reflected in the character of the castings. Apparently the crystal expansion and contraction theory has its weak points.

Gates Are Responsible

A more plausible theory has been advanced on several occasions by Charles Vickers. He claims that the microscopic vacancies are caused by a drainage of the eutectic portion of the alloy to a lower part of the casting. This takes place after the formation of the crystalline part of the metal.

To obtain a dense metal structure it is necessary only to provide a reservoir that will remain liquid until after the casting has solidified. This is what is done in the method described by Mr. Parry. He provides a head of metal in position to seep down by gravity to every casting in the group. The foregoing theory also accounts for the efficacy of risers and chills in producing leak proof castings.

Based on this theory, alternative methods are shown in Fig. 152 for gating a long bushing molded horizontally in the usual manner with one half of the mold in the cope and the other half in the drag. The method shown at *A* Fig. 152 is for a horizontal mold with the metal dropped from a long basin through a number of pop gates spaced equidistantly along the highest part of the mold.

The principal objection to this method is that a considerable amount of metal will be required to fill the basin. The extra expense of melting all this metal will have to be charged

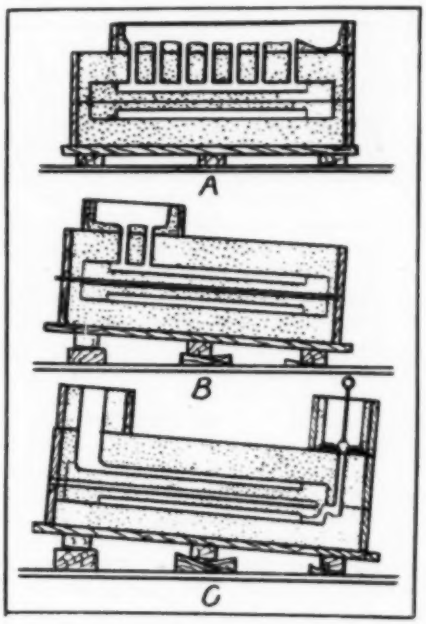


Fig. 152—Various Methods of Pouring Sleeve Castings in Horizontal and Inclined Position

to the casting. Amount of metal in the basin may be reduced to a considerable extent without sacrificing the benefit of top pouring, by tilting the mold and pouring the metal through a basin and pair of pop gates at the high end as shown at *B* in the same illustration.

Either of these methods introduces a hazard if the sand in the mold is not sufficiently strong to resist the force of the stream of metal that may be thrown against the walls. Also dull metal poured from above has an unpleasant faculty of entrapping air to show up later as blowholes in the casting.

Poured at Bottom

A gating method to avoid plunging and spattering of the metal is shown at *C* Fig. 152. Through this gate the metal enters the mold at the lowest point, where it forms a gradually advancing pool instead of racing over the sand face. The fall of the metal is broken. The mold is filled slowly and without agitation and no air is carried in with the stream. The inclined mold with sprue and gate at the lower end, and with a riser at the upper end, will produce a good

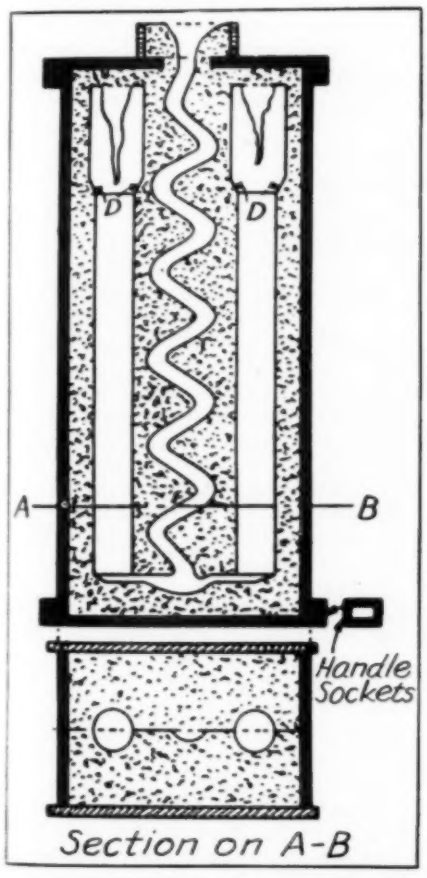


Fig. 151—Aluminum Bronze Sticks Require Special Gates and Risers

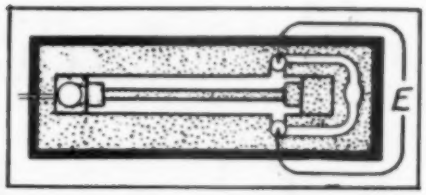


Fig. 153—Metal Enters the Mold From Two Sides at One End

casting. The gate is formed easily by attaching a piece of wood or metal the desired shape and size in the corebox.

Perfectly satisfactory castings may be secured through use of the gate shown in Fig. 153. In some instances a single sprue and gate at one side are sufficient. In others it is advisable to use two sprues, one on either side of the mold as shown in the illustration. Manifestly a long, thin bushing must be filled more rapidly than a casting of similar weight, but short and thick. The temperature of the metal is an important factor, but a proper discussion of that subject lies outside the scope of the present series of articles. Brief references have appeared and will appear occasionally.

Prevent Air Bubbles

Next in importance after a proper gate is a riser large enough to supply liquid metal to the shrinking casting, and high enough to exert pressure on the metal in the mold and thus prevent the inclusion of air or gas bubbles in the molten metal. In some instances all the gas generated in the core does not pass through the single inadequate channel provided. Some of this gas works through the sand in the core and tries to escape through the metal surrounding the core. This point has been touched upon before, but it will bear reiteration.

When a bushing casting is found to be clean and solid on the outside, but spongy or porous on the inside, attention first should be directed to the core instead of to the metal or the manner in which it was melted. In extreme cases castings honeycombed throughout may be traced to defective cores. Unless the gas can escape readily from the core, some of it will try to escape through the surrounding metal, and inevitably some of it will be trapped.

Temperature of the metal sometimes is the controlling factor. A minimum amount of gas bubbles that might escape through liquid, high temperature metal, will remain in suspension in metal that is dull and viscid.

This is the twenty-eighth of a series of articles dealing with the various types of gates and risers used in the foundry industry. The twenty-ninth installment will appear in an early issue.
—The Editors

Standardization of Horizontal Core Prints Is Desirable

By Walter C. Ewalt

CONSIDERABLE difference of opinion exists between the patternmaker and the molder on the subject of core prints. Rules or formulas should be derived to govern the length of those items because of the conservation of time and material that would result. One of the advantages would be in the estimation of castings from blueprints. With a set of rules or formulas, it would be possible for foundrymen to tell by the additional length of print necessary, the size of flask required for the job. It also would enable him to tell how many patterns could be placed safely on a plate, it would eliminate unnecessary ramming, it would give him the same knowledge as his competitor, etc.

Several items must be considered when taking up the subject of core prints. Among them are crushing strips, clearance between end of core and mold, total bearing surface of core, angular projections of cores, safe load per square inch of mold, maximum head of metal, strength of cores with and without rods, weight of core, weight of iron, and buoyancy of the core.

Clearance Is Necessary

Crushing strips eliminate sharp corners and prevent washing and crushing. A crushing strip is shown at *A* in Fig. 1. Clearance is required between the end of the core and the mold to prevent crushing. Considering the question from a production standpoint, the core setter can place the core in the mold faster if he has plenty of room, as shown in *C*, Fig. 1. Core prints often are required to support a relatively large body of sand, and, therefore, the bearing surface of the core print is an important consideration in the design of prints. Length of the bearing surface of any core print is the area between the fillet and the clearance, which is shown at *D*, Fig. 1. Some consideration also must be given to the fracture of the sand that may occur at *E* in Fig. 1.

The use of fillets is desirable between the core print and the casting, as sharp corners are not conducive to the production of sound castings. For that reason the author recommends the use of fillets of the following dimensions with the diameter core prints indicated:

Diameter of Core Print in inches	Radius of Fillet in inches
⅛ to ½	1/32
⅝ to 1⅞	3/64
2 to 4	5/64
4½ to 12	1/8
Over 12	3/16

The author also recommends the following clearances for for the diameter of cores given:

Diameter of Core Print in inches	Clearance in inches
⅛ to 1½	1/32
1⅝ to 4	3/64
4⅛ to 12	1/16

Depends on Buoyancy

As an example of the influence which angular projections on cores exert on the diameter of the prints of a core, take the example shown in Fig. 2. Core prints *A*, *A'* and *B* are equal in diameter and are equidistant from the center of the casting. Core *AA'* supports one end of core *B*. Since the buoyant force acts on the area of the core in the mold, the length of the core print *B* may be made less than the prints *A* and *A'* in proportion to the difference in areas of the respective cores in the mold. Assume in the same figure that *A* and *A'* have the same diameter and that the diameter of *B* is less than *A* and *A'*. In that case, the exposed core area of branch *B* still is less than the areas of *A* and *A'* and the print may be made still shorter in proportion to the difference in diameters. Conversely, if the branch *B* was made larger in diameter, the core print would have to be made longer. Thus it may be seen that the required area of core prints depends upon the area of the core in the mold or should be proportional to the buoyant pressure exerted against the core by the iron.

Considers Safe Loads

With regard to safe loads per square inch of the mold, an article by H. W. Dietert and W. M. Myler Jr., in the Jan. 1, 1926 issue of THE FOUNDRY, gives the following green sand strength figures in pounds per square inch or the pressure which sand with various clay contents will support:

Type	Pounds per Square Inch	Clay, Per Cent
No. 3 Boiler Heap	3	16.7
No. 3 Sand H. & H.	8	43.0
Warren Pitt	3	15.0
No. 7 Zanesville Sand	13	40.0
No. 4 Brandes Sand	5.25	16.4

Tests in the foundry where the author is employed gave results ranging from 4.4 to 7.2 pounds per square inch.

The author does not believe that maximum head, gas, momentum, etc., exert any appreciable influence on the core. It is his opinion that the cope must withstand those pressures. He also believes that dry sand cores will withstand a greater crushing stress than green sand cores.

Buoyancy is stated to be the upward pressure exerted by a fluid on a body emersed in it or floating on it. It is equal to the weight of the fluid displaced. Practically the only reason for special attention to core prints is due to that phenomenon. If it was not for the buoyant action of the iron on entering the mold, the only core prints that would be necessary would be those necessary to hold the core in position. However, when the iron fills the mold, it begins to exert a pressure upward on the core.

Study Problems

PATTERNMAKERS often are insufficiently acquainted with molding processes to design patterns to the best advantage for easiest molding. Much of that difficulty is being overcome by close co-operation between foundrymen and patternmakers, and the formulation of certain standards for pattern making by the American Foundrymen's association. This article is abstracted from a paper which was presented for consideration at the Chicago meeting of the A. F. A. on the subject of pattern standardization. The author is foreman of the wood and metal pattern shops, Walworth Co., Kewanee, Ill., and has contributed many articles on pattern making which have appeared in THE FOUNDRY.

That is due to the fact that core sand weighs 0.065 pounds per cubic inch while iron weighs 0.26 pounds per cubic inch. The ratio of 0.065 to 0.26 is 1 to 4. If the core was not held in position by the core prints, it would float in the iron and thus the purpose for which it was intended would be nullified.

Core Print Formula Derived

Consider the simple casting as shown in Fig. 3. For the core to be successfully held in position by its core prints, the volume of the core in the mold multiplied by the pressure exerted on the core must at least equal the upward pressure that the core prints will withstand. In this particular case, let C = Diameter of the core, L = Length of the casting, I = Length of core print, W_1 = Weight in pounds per cubic inch of iron, W_2 = Weight in pounds per cubic inch of core, and P = Pressure the mold will support per square inch. Then $\frac{\pi C^2 L}{4}$ = Volume of the core in the casting, $(W_1 - W_2)$ = Pressure per square inch exerted on the core, and $2\ (C \times I \times P)$ = Pressure core print will support. Since the pressure which the core print must withstand is equal to the pressure exerted against the core,

$$\frac{C^2 L\ (W_1 - W)}{4} = 2\ (C \times I \times P).$$

Solving for I, and assuming 4 pounds per square inch pressure,

$$I = 0.02438 \frac{V}{C}$$

where V equals the volume of the core in the casting. Assuming in Fig. 5 that C equals 10 inches; L equals 20 inches and P equals 4 pounds per square inch, solving the equation for I gives 3.83 inches, the minimum length of the core print.

Applies Under Other Conditions

The following formulas may be applied for the same purpose under the following conditions:

If the casting is round with a circular core print, the length of the core print equals $0.01915\ CL$. If the casting has a square section with a square core, length of the core print may be obtained by the formula $0.02438\ CL$. If the casting section is rectangular with a rectangular core, the core print length equals $0.02438\ AL$ where A is the long dimension of the rectangle. If the casting is rectangular in section with an eliptical core, the formula becomes $0.01915\ AL$. All the above formulas are obtained by substituting the various values for V in the original formula.

If the volume of a core with a branch, as shown in Fig. 2, is desired, the formula $V = 0.4749\ r^3$ will give the desired results, providing the branch has the same diameter as the main body of the core and that it copes over the main body.

Fillets have not been taken into consideration in figuring the core bearing surface, nor has the weight of that part of the core resting on the mold. That is allowed as a safety measure. From the above information, it appears to be comparatively easy to ascertain the correct length of core prints. The author believes that as the molds are made larger, they are rammed harder and the strength is greater. In that case the pounds per square inch pressure that the mold will stand should be estimated approximately as follows:

Diameter of core in inches	Value of Constant P
1 to 4	2
5 to 8	3
9 to 13	4
14 to 18	5
19 to 23	6

Different values of the constant must be used for various metals and if more prints are used to support the core different values again must be used.

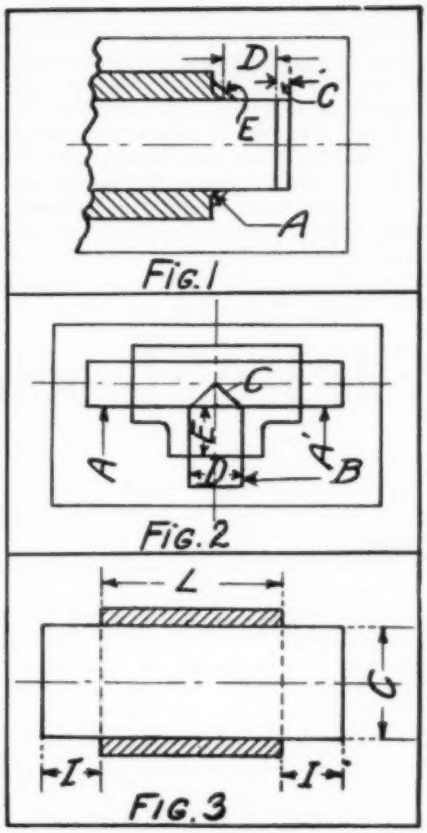


Fig. 1—Bearing Surface and Clearance of Core. Fig. 2—Length of Prints Depend Upon the Area. Fig. 3—A Simple Casting May be Used to Derive the Formulas for the Length of Prints

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Nicholas & Miller, 1418-20 McCormick building, 332 South Michigan avenue, Chicago, dealers in pig iron, silveries, ferroalloys and coke, has changed its name to Miller & Co. No change is to be made in the conduct of the business, its personnel or agency arrangements. J. W. Miller continues as senior member of the firm.

Pays Tribute to Work of Eugene Smith

During the course of his 60 years of service with the Crane Co., Chicago, Eugene W. Smith, who died Jan. 19, was responsible for many innovations in foundry practice. While his work in numerous fields, especially the practical testing of foundry sands, has been accorded international recognition, his fellow workers at the Crane company were best acquainted with his pioneering efforts. The following tribute to his work was sent THE FOUNDRY by L. W. Spring, chief chemist and metallurgist, the Crane Co.:

"Gene," as you know was quite an outstanding figure in the foundry industry in this country, and it is a question whether he was second to any of those of this particular period.

Becoming indentured to Crane Co. on March 10, 1873, as a boy 15 years of age, he never left Crane Co. during the approximately 59 years succeeding, except for something like 9 months during a depression in which he was able to find more work elsewhere. However, years after his return to Crane Co. he was credited by Mr. Crane with continuous service.

When Crane Co. hired its first chemist in 1888, with his usual interest, Mr. Smith wanted to know what it was all about, and instead of belittling the chemist and attempting to defeat his work, as occasionally happened in those days, he went to J. Dunraven Young, a commercial chemist, and worked in his laboratory evenings to get an understanding of the science and something of its application. Throughout his long career, while sometimes differing with the chemist, he never tried to circumvent but tried to help him in every way.

For many years Mr. Smith was a well-known figure at conventions of the foundrymen, taking a very active part. He was president of the Chicago Foundrymen's club for a number of years and had a great deal to do with most of the activities of the various foundry organizations of the Middle West during a long period.

One of Mr. Smith's strong points was his high enthusiasm for everything which he undertook. New methods of molding, of core making, the mixing of foundry sands, facings, etc., found him enthusiastic and a booster with practically every advance in the art. Likely it was this enthusiasm which kept him so young and agile. One of his friends termed him the "youngest old man" he ever knew, for his enthusiasm and willingness to aid in any new experiment, whether his own or that proposed by the chemist or metallurgist, or another, always was forthcoming to bring about the end sought for.

Many tests in the engineering and commercial world are not entirely defensible from the scientific standpoint,

yet they have a valuable application. There is no question but that the A. F. A. scheme of sand testing is more scientific, yet the simple and much less expensive vibratory test developed and so strongly advocated by Mr. Smith has accounted for improved results, when used intelligently by foundry foremen, even though, like many commercial tests, some of the effects may be considered to be psychological. In developing this test, Mr. Smith secured hundreds of samples of molding sands brought from all of the states of the Union, with some from foreign countries. First at his foundry office and later at his home in Chicago he classified these, and explained them at length to all comers. It was his last great enthusiasm, which still persisted after nearly 10 years. Part of his collection was exhibited last year at the A. F. A. convention in Chicago. The A. F. A. has been asked to see that the collection is not scattered but preserved, if available, for more or less permanent exhibit.

He was active up to his final sickness. Having already come part way to his usual work on the morning when he was taken home ill, he died after an illness of approximately one week.

Determine Chute Location Easily

IN LOCATING the chute to receive the discharge from a belt conveyor, it is often desirable to take into account the trajectory, or parabolic path the material will take under the combined influences of gravity, speed of belt in feet per minute, and diameter of head pulley in inches.

The somewhat complicated formulas involved, have been worked out by the Link-Belt Co., Chicago, and presented in the convenient chart which is shown in the accompanying illustration. The vertical scales of the chart are so proportioned in their divisions, and relative locations, that the use of a straight edge will furnish much of the desired data. The right hand scale shows diameters of head pulleys in inches. The inside scale shows velocities of conveyor belts in feet per minute on the one side of the line; and on the other side, a value *X*, which is of a convenient length to use for dividing the tangent line (explained later) into sections. These furnish division points from which to measure vertical drops in inches (listed in the tabulation at top of chart). The lower ends of these vertical lines are points through which the trajectory curve is to be drawn.

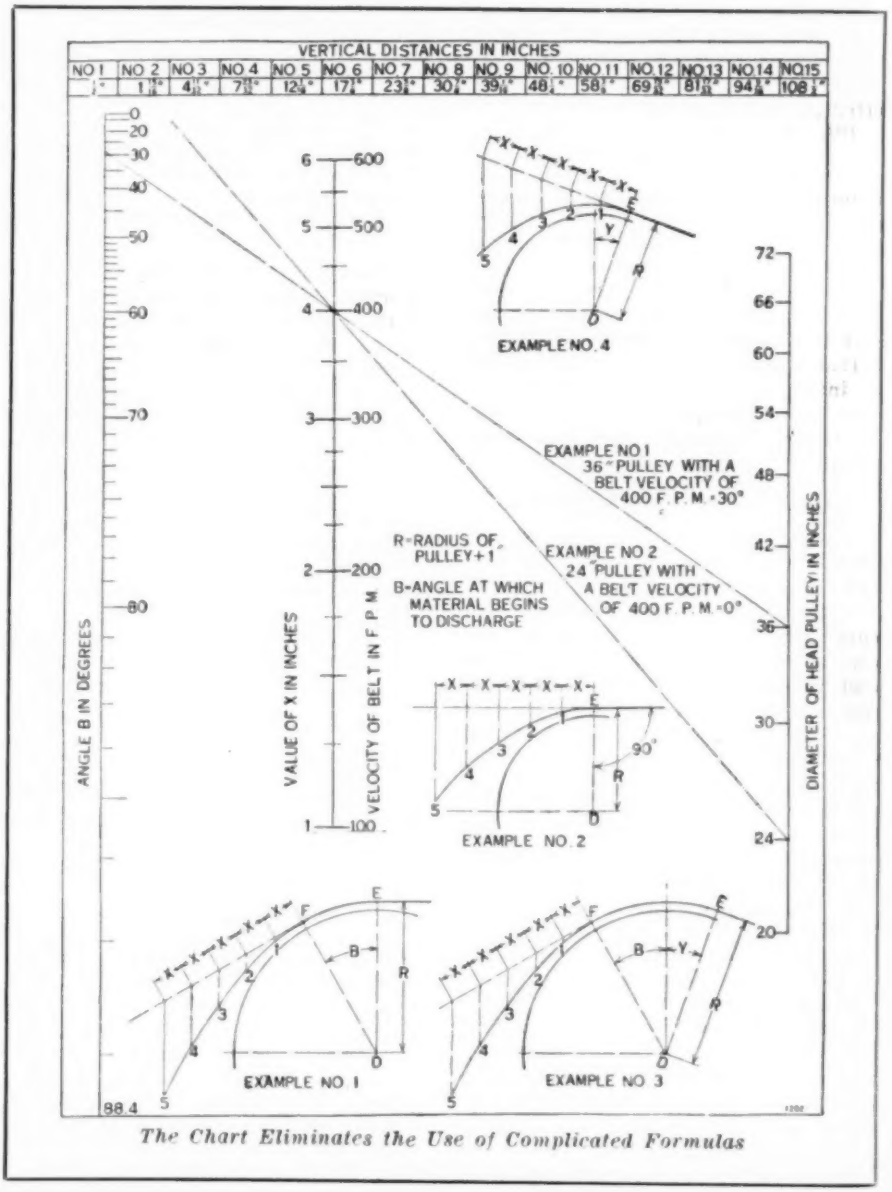
The scale at left is used for finding value of angle *B*, which measures the arc of contact of the material on the head pulley (starting at the vertical radius *DE*). Lay a straight edge or taut string across the scales at points indicating the diameter of pulley and velocity of belt involved. The extension through left hand scale shows corresponding value of angle *B*.

Starting with an imaginary line representing the straight path of the conveyor as it approaches the head pulley, locate a base radius line (*DE*) at right angles to the conveyor line, letting it equal in length the pulley radius plus 1-inch, or radius item *R*, assumed as the effective distance of the load from center of the pulley.

With radius *R*, inscribe an outer arc *EF*, through which the material remains in contact with the belt on the pulley, and draw secondary radius line *DF*. The angle *B* is formed by radii *DE* and *DF*. At intersection *F*, draw a tangent line, from which to drop vertical lines to locate the trajectory.

Divide the tangent into sections representing the length of *X* in each case. From the division points drop vertical lines of lengths given at top of chart; for instance, at end of section No. 1, ½ inch; at No. 2, 1 15/16 inches; at No. 3, 4 11/32 inches, and so on through as many sections as may be required for determining enough of the trajectory to locate the chute properly.

In Example 1 the conveyor is horizontal, the pulley 36 inches diameter and the belt speed 400 feet per minute. A straight line through 36


VERTICAL DISTANCES IN INCHES
NO 1 NO 2 NO 3 NO 4 NO 5 NO 6 NO 7 NO 8 NO 9 NO 10 NO 11 NO 12 NO 13 NO 14 NO 15
ANGLE B IN DEGREES
VALUE OF X IN INCHES
VELOCITY OF BELT IN F P M
DIAMETER OF HEAD PULLEY IN INCHES
EXAMPLE NO. 4
EXAMPLE NO 1
36 " PULLEY WITH A BELT VELOCITY OF 400 F. P. M. =30°
R-RADIUS OF PULLEY+1
B-ANGLE AT WHICH MATERIAL BEGINS TO DISCHARGE
EXAMPLE NO 2
24 " PULLEY WITH A BELT VELOCITY OF 400 F. P. M. =0°
EXAMPLE NO. 2
EXAMPLE NO 1
EXAMPLE NO 3
88.4

The Chart Eliminates the Use of Complicated Formulas

inches diameter and 400 feet per minute (on the chart), intersects the degree line *B* at 30 degrees. The tangent line is drawn from the intersection (*F*) of the outside circle made by *R*, with the line (*DF*) which indicates the side of angle *B*.

The tangent line is divided into sections *X* equaling 4 inches each, and from the division points, lines are dropped vertically to the distances indicated at top of chart, namely, ½ inch for No. 1, 1 15/16 inches for No. 2, 4 11/32 inches for No. 3, and so on through as many points as are necessary to determine the path of the material until it reaches the chute.

In Example 2, a horizontal conveyor having belt speed 400 feet per minute, and head pulley 24 inches diameter, the line does not indicate any degrees for an angle *B*, and the material would leave the pulley at its top. The tangent line would be a continuation of the conveyor surface, counting the effective distance of the load from center of pulley as being 1 inch above the face of the pulley, as previously explained.

Examples 3 and 4 introduce the modifying influence of an inclined instead of horizontal path for the conveyor as it approaches the head pulley, and the effect of the velocity on this item.

To determine whether the load will start to leave the pulley at *E* or at *F*, find an indicator figure by the following formula:

$$\text{Indicator figure} = \frac{V^2}{G \times R \times \text{Cos } Y}$$

Where V = velocity in feet per second. G = action of gravity, or 32.16 feet per second. R = radius R measured in feet. Y = angle of inclination of conveyor. If the indicator figure is less than 1, the trajectory begins at *F* (Example 3), angle *B* remaining the same as for a horizontal belt (30 degrees in this case). If the indicator figure is more than 1, the trajectory begins at *E*, as in Example 4.

In Example 3, using same data as in Example 1, except that the conveyor is inclined 20 degrees (equaling angle *Y*), the indicator figure from formula is less than 1, and trajectory starts at *F* (30 degrees to the left from the vertical radius line).

In Example 4, using same data as in Example 2, except for an incline of 20 degrees, the result of the formula is greater than 1, and trajectory starts at *E*, at an angle of 20 degrees to the right from the vertical radius line.

Diamond Rubber Co. Inc., Akron, O., recently has developed a new dressing for rubber belts which is being marketed under the name of Grippite. It is claimed that the new dressing is not greasy or inflammable and will not be harmful to the belt or pulley. The manufacturer also states that the effectiveness of the dressing increases with use.

Traces Foundry Trends in Philadelphia

Robert Gray, industrial research department, University of Pennsylvania, Philadelphia, addressed the regular monthly meeting of the Philadelphia Foundrymen's association on "Production, Prices and Trends in the Gray Iron Foundry Industry in the Philadelphia District." The speaker illuminated his discussion with charts showing the fluctuation and trends of production, the level and trend of selling prices, the casting production of foundries in Philadelphia and those outside the city.

B. H. Johnson, Florence Pipe Foundry & Machine Co., Florence, N. J., discussed some general observations of conditions in England. Mr. Johnson recently completed a business trip in that country.

The meeting, which was held Feb. 10 at the Manufacturers' club, was presided over by Julian B. Greenstreet, president of the association. About fifty members and guests were present.

Book Review

Handbook of Business Administration, by W. J. Donald, managing director, American Management association, fabrikoid, 1753 pages 4½ x 7 inches, published by the McGraw-Hill Book Co. Inc. and supplied by THE FOUNDRY, Cleveland, for $7 plus 15 cents postage and in London by the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster.

For perhaps the first time, many important discussions of the subject of modern management methods have been collected and published in one volume. The work contains not only the contributions made in the publications of the American Management association, but also much other material pertaining to the field.

The work is divided into six main sections covering the following factors: Marketing, financial management, production management, office management, personnel management, and general management. The material included under each of the six divisions is exceptionally broad in scope. For example, under the section devoted to production management, the first chapter is a discussion of the "History and Fundamentals of Production," by Charles H. Hatch, the second chapter provided a treatise on "Organization of the Manufacturing Division," by Percy S. Brown and the third chapter contains a study of the "Industrial Plant," by Robert P. King.

The remaining chapters are as follows: "Plant Layout," by Charles H. Hatch; "Machinery and Equipment," by W. S. Powers; "Resarch Development and Design," by R. G. Caswell; "Production Control," by George T. Trundle Jr.; "Motion Study," by Lillian M. Galbreth; "Incentives and Supplementary Wage Payments," by Kenneth B. Anderson, E. E. Brinkman and E. H. Little; "Quality and Inspection," by Robert W. Kent; "Operating Data for Line Officials," by F. L. Sweetser; "Purchasing," by F. A. Compton, and "Storekeeping," by Stabley P. Farwell.

The handbook should prove exceptionally valuable to any executive dealing with any of the various divisions of management.

Institute Forms Groups

A. C. Ziebell of the Universal Foundry Co., Oshkosh, Wis., is chairman of the newly formed Milwaukee chapter of the Gray Iron institute according to Arthur J. Tuscany, Cleveland, institute manager. C. P. Wolfe of the Wisconsin Gray Iron Foundry, Milwaukee is technical chairman; George Kneisler, Vilter Mfg. Co., Milwaukee, cost chairman and E. L. Wieland, Milwaukee Gray Iron Co., merchandise chairman.

Charles F. Scherrer, Davenport Foundry & Machine Co., Davenport, Ia., is chairman of the Quad City chapter which is co-operating with the Quad City Foundryman's association.

Group Makes Estimates

A discussion of estimates featured the regular meeting of the Malleable club, Milwaukee, held Feb. 9 at the Blatz hotel. Prof. Scott Mackay, University of Wisconsin, presided.

The discussion was based on estimates made from blueprints of a 12-ton hydraulic jack casting. The necessity for securing utmost soundness in this casting and the desire to lessen the weight of sprue as much as practical led to some ingenuous suggestions for molding the casting and served to bring out considerable valuable information regarding the problems which are introduced in the foundry making castings to resist hydraulic pressures.

To Make Welders

Harnischfeger Corp., Milwaukee, recently acquired the manufacturing rights for the arc welding equipment formerly marketed by the Northwestern Mfg. Co., and will produce the welder in the same range of sizes and with the same features previously incorporated. Klaus L. Hansen inventor of the welder, has joined the staff of the Harnischfeger Corp.

Research paper No. 380 published by the bureau of standards describes the use of zinc oxide for the determination of cobalt and manganese in steels. Copies of the paper may be obtained from the superintendent of documents, Washington, for 5 cents.

Chicago Groups Meet Jointly To Study Casting Design

FOUNDRY engineers, speaking before a joint meeting of the Western Society of Engineers; Chicago section, American Society of Mechanical Engineers; Chicago Foundrymen's club; Chicago group, Gray Iron institute, and the Chicago Foundrymen's association at the Engineering building auditorium on Monday evening, Feb. 8, told how castings can be relied upon to find successful adaptation in engineering design, particularly for uses now barely recognized. The meeting was one of a series being sponsored by the American Foundrymen's association and other foundry groups in various sections of the country. Approximately 200 executives and engineers were present.

Point To Advantages

A paper prepared by W. G. Hanawalt, assistant superintendent, George H. Smith Steel Casting Co., Milwaukee, and read by W. J. Donnelly, secretary-treasurer of that company, dealt particularly with factors affecting design of steel castings. Malleable castings characteristics and physical properties were presented in a paper by J. H. Lansing, works manager, Danville Malleable Iron division of Allith-Prouty Co., Danville, Ill. R. A. Bull, director, Electric Steel Founders' Research group, Chicago, had charge of the discussions and presided after the meeting was turned over to him by Frank D. Chase, Frank D. Chase Inc., president of the Western Society of Engineers.

Mr. Hanawalt's paper emphasized the fact that knowledge of some of the fundamentals of foundry practice and an understanding of the metal during the period of solidification and subsequent cooling has been decidedly profitable to large users of steel castings. He also suggested factors that add to the reliability of castings for parts in which bars, shapes and forgings find service, and pointed out advantages of castings in lending themselves to serve engineering needs. The paper specifically dwelt on the manufacture of small electric steel castings on a production basis. Errors in pattern construction were given important consideration. Other points stressed were heat treating and the wide variety of alloy steel castings produced to meet numerous specifications.

Minimum thickness of sections occupied much of the discussion of the paper, while a number of questions were answered pertaining to design and characteristics for parts subjected to surface wear. Chromium-nickel and other alloys also were discussed. It was brought out that while sections under ¼-inch and even to 1/16-inch,

Frank D. Chase

have been cast successfully, depending upon the area of the section, the 1/16-inch sections are not regarded as commercially practicable.

Mr. Hanawalt's paper pointed out that because steel is poured at high temperatures the duty required of the molding sand is severe. In practically every steel foundry today molding sand is being checked carefully for strength, moisture and permeability, the nature of the bonding materials carefully watched, the fusion points known, with the result that there has been, during the past few years, a vast improvement in appearance, in freedom from cracks and in general soundness and serviceability of the casting.

Speaking of welding, Mr. Hanawalt stated that while the process may have replaced a few steel castings, it has resulted in the replacement of other cast materials by steel castings, since the latter readily can be incorporated in any welded structure. A great many castings are now being furnished which are later to be welded together with standard bars or shapes to build up structures This is a natural development and one which should contribute as much to the steel casting industry as it takes from it.

It was stated that the designer of steel castings also is interested in the development, during the past few years, of alloy steel castings. Prior to the last decade, steel castings rarely were available except in carbon steels, but since that time requirements have changed until now castings are available in almost as great a variety of alloys as the rolled steels They are produced under expert metallurgical supervision and the analyses are held within the limits of S.A.E. specifications for rolled steels. There are alloys available to give high wear resistance, others to give tensile strength or high yield points, and still others for high impact strength. Annealing, normalizing and heat treating are employed to bring out the required properties of the steel. The value of this development to the engineering profession has been incalculable.

Use Alloy Steels

The use of alloy steels and especially the use of heat treated alloys or carbon steels has increased tremendously during the past few years, according to the speaker. Where ten years ago the amount of that material produced was almost negligible, today there are a great many foundries producing more than 50 per cent of their output in special steels, and in several instances there are foundries heat treating (quenching and drawing) almost half of their tonnage. The designer cannot afford to overlook the possibilities both in the use of alloy steel castings and in the subsequent heat treatment of them. Hardened dipper teeth, shovel points, buckets, pulverizer hammers, truck wheels, track shoes and various other castings are working today under the most severe abrasive conditions and giving satisfactory service. Heat treated castings in heavy excavating or dirt handling equipment are daily being subjected to shock loads which only a few years ago would have been unbelievable.

Mr. Lansing stressed ease of machining, corrosive resistance and structural composition of annealed castings. He illustrated his talk with a number of slides showing applications and special castings designs, in-

cluding high strength malleable iron for rails on large bridge spans. He asserted the industry has available to buyers castings of 54,000 pounds ultimate strength, a yield point of as much as 35,000 with 18 per cent elongation in 2 inches. He cited the wide adaptation of malleable castings in the automotive industry because of the ability to withstand shock, resist wear and provide advantages in machinability. He presented mechanical and physical properties from data taken from the symposium on malleable which was presented last year. Discussion related to pattern construction for feeding larger sections in molding practice, corrosion resisting qualities for underground work, and the use of large fillets.

The speaker declared that malleable iron in its uses has kept pace with the development of transportation, first serving for harness and wagon parts, later becoming an important material of railway car construction, and now furnishing hundreds of thousands of tons annually to the automotive industry. Its part in the development of agricultural machinery and of other machines and tools also was mentioned. He listed eight fundamental acts of importance in consideration of outstanding properties of malleable iron, and in illustrating the increasing use of higher strength malleable iron, showed test results on a 2600-ton order of side stakes for railway gondola cars. This order was placed on the basis that standard test bars, representing each heat, were to have a yield point of not less than 35,000 pounds, and an elongation of not less than 18 per cent in 2 inches.

Meet Test Specifications

Mr. Lansing said that a large number of foundries are prepared to accept orders on the basis of a minimum standard test specification of 54,000 pounds ultimate strength, 35,000 pounds yield point and 18 per cent elongation. Numerous tests have established conclusively that a machined malleable iron test bar is not of appreciably less strength and ductility than an "as cast" bar of equal diameter. This was mentioned in view of the once prevalent fallacy that most of the strength of malleable iron was in the decarburized surface or "skin," and that the metal core was therefore of considerably less strength.

With regard to the important matter of design Mr. Lansing stated that where various considerations indicate the ultimate economy or desirability of an intricate design, malleable iron lends itself in a remarkable manner to its being cast in any conceivable form without prohibitive expense. However, these properties which permit great latitude in design should not obscure the fact that, in the great majority of cases, considerable economy may be effected by recognizing certain factors that make for the most economical production of the finished part. He referred to the statement recently made that the price per pound of a casting is the true measure of designer—foundry correlation—and stated a much more valuable criterion is the total cost of the finished part. In some cases it is possible to eliminate certain machine operations by redesign or reduction of stock, and in other cases the addition of more adequate finish allowance eliminates rejections and results in a lower ultimate cost per part.

To avoid unnecessary expense and delay, he suggested the customer submit tentative designs to the malleable foundry for suggestions as to possible changes which, while not affecting utility, will aid in producing a better and less expensive casting.

Beardsley & Piper Co., Chicago, showed motion pictures of modern foundry equipment, including molding and sand handling and conditioning equipment.

Stress Design Problems at Pittsburgh

Problems relating to the proper design of castings occupied the attention of an audience of more than 75 attending the monthly meeting of the Pittsburgh Foundrymen's association, held in conjunction with the American Foundrymen's association at the Fort Pitt hotel, Pittsburgh, Feb. 15. Frank J. Lanahan, president, Fort Pitt Malleable Iron Co., Pittsburgh, and recently nominated for vice president of the American Foundrymen's association, presided as representative of the parent organization. Robert E. Kennedy, technical secretary of the association, also attended and spoke briefly.

Principal speakers on the general subject of, "Foundry Factors Affecting Casting Design," were K. V. Wheeler, general manager, Lebanon Steel Foundry, Lebanon, Pa., and J. H. Rowe, technical control and development section, Aluminum Co. of America, Cleveland. Mr. Wheeler discussed the various factors as regards mechanical and metallurgical considerations. Under the former he pointed out the advisability of eliminating sharp corners and irregular parting lines, while troubles incident to the cooling of liquid metal in the mold and to the shrinkage of the casting after solidification also were detailed and remedies suggested. Improved design frequently can eliminate the stresses set up in castings upon shrinkage in the solid state, the speaker pointed out, illustrating his remarks by drawings of typical steel castings.

A paper presented by Mr. Rowe dwelt principally with the design of aluminum alloy castings. Mr. Rowe emphasized that success or failure in producing castings begins on the designer's drawing board. Both papers were read before a recent meeting of the Philadelphia Foundrymen's association and were discussed in detail in the Feb. 1 issue of THE FOUNDRY.

Prof. Enrique Touceda, Malleable Iron Research institute, spoke on activities of the organization in improving the physical properties of malleable castings.

Book Review

Proceedings of the American Society for Testing Materials, Vol. 31, 1931, Parts I and II, 1120 and 1028 pages, respectively, 6 x 9 inches, paper, cloth or half leather, published by the American Society for Testing Materials, Philadelphia, and supplied by THE FOUNDRY, Cleveland, for $5.50 in paper; $6 in cloth, and $7 in half leather for each part, plus 15 cents postage. In London the books may be obtained from the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster.

Part I of the *Proceedings* is devoted to committee reports, new and revised tentative standards and revisions of standards of the society presented at the annual meeting. The committee reports relate to steel, wrought iron, cast iron, iron-chromium and related alloys, effect of temperature on the properties of metals, corrosion of iron and steel, fatigue of metals, etc. The volume also includes a number of papers such as fatigue tests of low carbon steel at elevated temperatures, creep testing apparatus, and correlation of cast iron test bar and casting by volume surface ratio. The nonferrous reports deal with nonferrous metals and alloys, copper and copper alloys, die cast metals and alloys, electrical heating and resistance alloys, light metals and alloys, and corrosion of nonferrous metals and alloys. Papers appended to the reports include the effect of composition on aluminum-base die casting alloys, and lead-base and tin-base alloys for die castings. Reports of nonmetallic materials such as stone, concrete, cement, lime, brick, are included.

Part II of the *Proceedings* contains the technical papers which were presented at the annual meeting. Many of the papers may be grouped under the heading of metals which comprises 26 papers and includes those of the symposium on malleable iron castings. Other papers deal with fatigue, endurance testing, magnetic analysis, damping capacity, and corrosion of metals. Executives will be interested in papers presented by five prominent executives on the economic significance of specifications of materials. Part II also contains a number of papers on cement and concrete, lime, gypsum, and clay products; a symposium on the weathering characteristics of masonry materials; a symposium on the abrasion testing of rubber, and papers on miscellaneous materials. The book is unusually complete and a valuable reference for all those engaged in engineering development.

Questions & Answers on FOUNDRY PRACTICE

GENERAL

Rustproofs Iron Parts

We would like to have some information on sherardizing. We have an item to be made of iron, and desire to rustproof it for outside use. We have been advised to sherardize the part, and would like to know of other methods.

Sherardizing is the name given to a process for zinc coating iron and steel. The objects are placed in zinc dust contained in rotatable drums which are heated to 825 to 845 degrees Fahr. from 5 to 9 hours. The zinc alloys with and coats the surface of the metal similar to hot galvanizing. In hot galvanizing the cleaned iron objects are dipped into a bath of molten zinc and the excess zinc shaken off. Electrogalvanizing is plating the metal with zinc electrically.

In addition to the processes mentioned, a number of other electrically deposited coatings such as copper, cadmium, nickel, chromium, etc., are available not to mention enameling, lacquering, and painting. The choice of any coating will depend upon the price you wish to pay for it, and the service you expect the coating to withstand. If you desire a comparatively inexpensive metallic coating, probably painting the surface with aluminum or one of the bronze paints will be satisfactory.

Q & A

Castings Show Coldshuts

We have tried several types of gates on the sides and rims of our bath tub castings, but the loss on this class of castings is excessive. We use the same sand and iron on smaller castings of the same general type, lavatories, sinks, etc., with satisfactory results. We have tried pouring the bath tubs with four small ladles, also with a single large ladle which fills a basin on top leading to the four sprues. Apparently the iron is hot and fluid, probably at a temperature of 2700 to 2800 degrees, Fahr. The sand shows a hardness of 55 on a testing machine. Rough areas appear on the surface of the casting. In some instances a hole 1-inch in area appears in the center of these rough places. The rough areas do not suggest sand erosion. The face of the casting is filled with wrinkles, and in some places lines 2 or 3 feet in length convey the impression that the adjoining bodies of iron were poured at separate periods and did not unite.

The natural conclusion from the evidence submitted, is that the gates are too small, or, that the iron is poured too slowly. However, this opinion is modified in consideration of the rough areas on the face of the casting. Irrespective of the temperature of the iron or the speed of pouring, if the steam from the sand cannot escape readily, it will set up a boiling action in the metal, which effectually will reduce the temperature and account for the holes, the roughness, the wrinkles and the cold shut streaks or lines. On account of the thin metal section of these castings it is apparent that the gates must be designed to distribute the metal uniformly over the entire area in a minimum period of time. It is immaterial whether four ladles are employed for this purpose, or if only one ladle is employed to fill a long basin leading to the four sprues. The essential feature is that the metal must enter the mold in a fast and continuous stream. Your sand may contain too much moisture, or it may not be sufficiently permeable for this particular type of casting. A process of elimination dealing with these features will show you which is responsible. Of course it is possible that your trouble may be due to a combination of two or more of the foregoing features. As a starting point for your investigation we suggest that you reduce the moisture content in the sand, ram it more gently in the upper part of the mold, arrange for easy and rapid escape of the steam, and increase the number of gates leading to the mold cavity.

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall
Cast Steel

H. A. Schwartz
Malleable Cast Iron

J. W. Bolton
Gray Cast Iron

All questions must be addressed to the Editor, The Foundry, Penton Building, Cleveland.

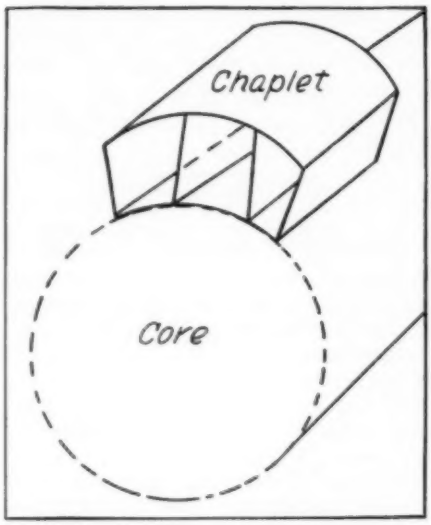
Q & A

Makes Lamp Post Cores

In the Dec. 1, 1930, *issue of* THE FOUNDRY, *an article by N. F. Hindle described the methods and equipment employed for making lamp post castings in close fitting iron flasks without bars and in which the sand is supported by sand strips at the joint and by plates on the outside top and bottom. Apparently the chaplets used on this job are not those with which I am familiar, straight stems with plates riveted on one end. I shall appreciate a description or a sketch of these chaplets. I am enclosing blueprint of a lamp post* 11 *feet in length, with an 8-inch opening at one end and a* 15/8-

inch opening at the other end. The outside presents quite an ornate design to which the inside conforms approximately and the taper is fairly consistent from the small to the large end. The average thickness of metal is ½-inch. Would you favor the use of a loam core?

Replying to the last part of the question first, the answer is no. Sharp sand mixed with any good binder to which you are accustomed and rammed in a half corebox will make the most satisfactory core for this casting. On account of its length and slimness, the core should be rodded as heavily as possible to prevent it from springing. A generous vent passage should be provided all the way through the core.



Box Chaplets Correspond Exactly to the Desired Metal Thickness

A large opening here will facilitate the escape of the gas during the pouring operation, and later will greatly facilitate the removal of the core from the casting. The best time to cut this vent passage is before the core plate is clamped to the corebox preparatory that to rolling the assembly over. In this connection it is interesting to note that many coremakers prefer to *flop* a long core of this kind on to a long level plate, or, two or more plates leveled on the core carriage. The corebox is turned slowly on edge to an upright position and then brought face down quickly to prevent the sand from slipping out of it. This method is quite a time saver.

Planed joints are desirable on the flasks in which these castings are molded, but if only a limited number of castings are required, shift can be made with unplaned joints, provided they are reasonably flat and straight. Two cast bars, or lacking these, two bolts about 4 feet apart are needed to prevent the flask from springing sideways. The sand strips 1-inch in width may approach to within 1 inch of the pattern.

Gates may be at one end or on top. Personally we prefer the top, six or eight ¼ x 1-inch pop gates spaced about 1 foot apart and fed from a long, narrow basin. Holes for their reception are provided in the cover plate. The time required to make up a runner of this kind is more than repaid in the better distribution of the iron and later in the cleaning room where practically no chipping is needed.

Proper chapleting on this core is highly important. A variation in the metal thickness will result in a crooked casting. The chaplets referred to in the article you quoted are known as box chaplets, made from tin coated thin steel plate and correspond exactly to the desired thickness of the casting. They depend on the hardness of the mold face to hold them in place. Naturally in a green sand mold a considerably greater number are needed, than where the stem type is employed, anchored against the bottom plate or board, or, bars across the top. In some instances an iron plug or a piece of dry sand core is rammed up in the sand at the point the chaplet comes into contact with it.

Q & A

Finds Fiber Stress

We had an inquiry from one of our customers regarding the fiber stress values of our gray iron, and would like to have some information on how that value is determined.

Methods for determining fiber stress values may be found in textbooks relating to the strength of materials. In a bar under tension applied axially without any flexure the stress is distributed uniformally across the cross section and the magnitude of unit stress is given by the formula

$$S = \frac{P}{A}$$

where P is the load applied; A is the area of the cross section at the fracture, and S the unit stress in pounds per square inch.

The extreme fiber stress usually is determined on materials under flexure or cross bending. The formula for determining the extreme fiber stress under such conditions is

$$S = \frac{Mc}{I}$$

where S is the unit stress in pounds per square inch; M is the bending moment in inch-pounds of the forces and couples on one side of the section; c is the distance of the extreme fiber from the neutral axis, and I is the moment of inertia of the cross section about the neutral axis. In a bar supported at the two ends and loaded in the center, as is the case with transverse testing, the magnitude of maximum bending moment is determined from the formula

$$\frac{Pl}{4}$$

where P is the load in pounds, and l is the distance between the two supports.

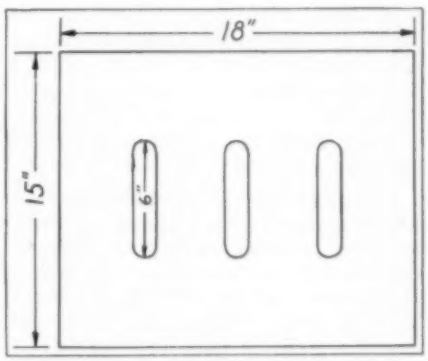
With a round bar I is equal to $\frac{3.1416d^4}{64}$, and c is the radius of the bar.

GRAY IRON

Castings Are Heavy

We have an order for some castings that must meet the A. S. T. M. A48-29 specifications. Can you give us the analysis of a pig iron which will be suitable either by itself or mixed with No. 1 oil field scrap? The castings weigh about 350 pounds and are 6 x 15 x 18 inches with three cored holes as shown in the accompanying sketch.

As you undoubtedly know, the specification mentioned refers to the tensile and transverse strengths obtained on a bar 1.20 inches in diameter and 21 inches long, and not to the strength of the casting itself. While we do not have any data on the analysis of oil field scrap, we believe that the silicon will range from 1.50 to 2.00 per cent, and you probably could make the castings from all scrap material. If you want to use an all pig mix, the silicon should be low say not over 1.25 per cent. Another suggested mixture is 15 per cent steel scrap, 50 per cent oil field scrap and 35 per cent pig iron containing about 2 per cent silicon.



Casting May Be Made from All Scrap

Q & A

Strength Is Low

Have you any data on the compressive strength of cast iron at temperatures around 1600 to 1700 degrees Fahr.?

There is little real information on the strength of cast iron around 1600 to 1700 degrees Fahr. because it does not have any, so to speak. The only extensive curve on compressive strength, as far as we know, is that given by Ingberg and Sale in the *Proceedings* of the American Society for Testing Materials, part II, 1926. The curve shows that at 1375 degrees Fahr. the immediate compressive strength is about 8000 pounds per square inch and rapidly approaching zero. The tests were short time, and

undoubtedly on sustained loads the material would flow under much lower loads.

Q & A

Structure Is Coarse

We are forwarding for your inspection a casting which forms part of a glass factory mold, a solid disk 10 *inches diameter,* 1*-inch thick with a* 3½*-inch diameter boss* 1*-inch thick in the center of one side. The iron in the casting shows the following analysis: Silicon* 2.00 *per cent, sulphur* 0.07 *per cent, manganese* 0.65 *per cent, phosphorus* 0.20 *per cent. You will note that the grain is open except on the face of the boss which was chilled by placing an iron block against the pattern. The flat face of the casting also shows several imperfections. We make a considerable volume of this glass factory work in weights from* 3 *to* 150 *pounds and will appreciate your advice on how to eliminate the typical defects shown in the casting offered for inspection.*

The appearance of the casting does not correspond with the analysis which is quite satisfactory for the line of castings you are handling. From this we assume that you only have a check analysis made occasionally and that the charging between the periods is held to a certain routine. A careful and personal check in some of these cases will disclose remarkable fluctuations. Since you make castings ranging in weight between 3 and 150 pounds it is only reasonable to assume that you run at least two mixtures, one for the light castings up to ½-inch in thickness and another for those that are thicker. From the surface appearance of the machined casting submitted for examination we are inclined to the opinion that this casting was poured from the mixture intended for lighter sections.

Another theory is that you are using a certain amount of steel in the charges, but that you are not getting a uniform mixture on account of using small ladles. The remedy for that is to use a mixing ladle under the cupola spout and melt the iron exceedingly hot. Apparently the casting was poured flat side up and that is responsible for several defects caused by slag lodging against the cope. Of course, the casting is machined on both sides and therefore no slag should be allowed to get into the mold, but it is possible that the defect would not be regarded so seriously if it appeared on the other side of the casting. Some form of a skim or strainer gate should be employed to insure the delivery of clean iron to the mold. By molding the casting flat face down, a much denser structure could be secured on the face by using a flat plate for the face of the mold, even with the present mixture. While the entrance of slag with the iron is the most plausible theory, it is possible that it was teveloped in the mold. The iron used for a chill on the boss may have been sufficiently damp to cause ebullition in the iron.

It is possible also that the chill might have been rusty or not cleaned properly. It is necessary that the chill face be cleaned by sandblasting or other means, and the molds should not be closed until they are ready to be poured.

Q & A

Wants Smooth Surface

We are making some small die blocks for stamping flat silver ware, but can not get them sufficiently smooth on the working face. We make them in green sand molds faced with black lead. The casting weighs about 10 *pounds.*

Presumably you are using a fine sand satisfactory in every way for small thin castings. The metal cools so quickly that it does not affect the sand adversely. The die block is comparatively thick and the metal remains fluid and at a high temperature long enough to fuse the clay substance in the sand. This material sticks to the face of the casting and accounts for the rough surface. Two methods are available for preventing this form of defect. The first is to employ a grade of sand in which the silica content is higher and the clay content lower than in the present sand. If a considerable volume of your castings suffer from the same trouble, this is the logical remedy. However, if the sand is satisfactory for the majority of your castings, and you only want to treat a small amount for the die block molds, you can secure smooth castings by mixing one part of sea coal with 10 parts of sand and using this mixture for a facing sand to be applied to the pattern. The facing sand need not exceed 1-inch in thickness. Black the molds as usual.

Q & A

Anneals Castings

Is there any way whereby pipe fittings cast in permanent molds may be annealed so that the slightly chilled exterior may be changed to a soft graphitic structure as in the interior portions.

At the present time a number of firms are conducting heat treatments or annealing operations on gray iron castings to facilitate machining or to relieve casting strains. The processes vary considerably in temperature employed and the duration of the period at the temperature. Temperatures vary from 800 degrees Fahr. to 1800 degrees Fahr., and the time from 1 to 5 hours. Factors that enter into the choice of time and temperature are size of castings, structural condition of casting (chilled, mottled, hard, etc.), and result desired.

If the castings are small and only moderately hard, a short heat treatment for 1 hour at 1500 to 1600 degrees Fahr. should produce castings that may be machined readily. If they are large or quite hard, the time will have to be extended so that the cementite has ample time to go into solution. In some cases a treatment around 800 to 900 degrees Fahr. may be ample to give the desired softness. If the castings have a white structure, a more drastic heat treatment is necessary. This may necessitate the temperature being raised to around 1800 degrees Fahr. to allow the cementite to go into solution.

A proprietary process developed by Schaap recommends heating the castings to 1600 degrees Fahr. and holding at that temperature for 3 hours. The castings then are cooled to a black heat in the furnace, removed, and air cooled. This method is claimed to give a uniformly soft product with only slight reduction of the strength properties.

Q & A

Iron for Stove Plates

Castings for our gas ranges and light coal stoves are poured from a mixture of No. 1*X pig iron, No.* 1 *machinery scrap and our own shop scrap. What do you consider the best mixture for these castings and what would you consider a suitable analysis of the iron? We shall be pleased to have any other information that will lead to the best practice. Do you know of any books or other literature on the subject of stove manufacturing?*

The iron you are using, No. 1X pig iron, No. 1 machinery scrap and shop scrap, mixed in approximately equal proportions are employed extensively in the production of stove plate castings. However, many other combinations also are employed depending on market conditions and the proximity of certain sources of supply. Iron of the following composition is suitable for these castings: Silicon 2.25 to 2.75 per cent; sulphur under 0.08 per cent; phosphorus 0.60 to 0.90 per cent; manganese 0.50 to 0.80 per cent. From the foregoing you will note that the iron may vary to a considerable extent and still serve satisfactorily. The manner in which the iron is melted is fully as important as the composition. It must be melted at a higher temperature than usual to attain a fluidity that will carry it to the extremeties of small, thin castings made in green sand molds. We know of no book on the subject or stove plate manufacture. Practically the only literature on the subject has appeared in THE FOUNDRY in the form of descriptive articles dealing with the methods and equipment employed in representative stove foundries throughout the country. Bound volumes in your public library may be consulted for the articles.

Problems in Nonferrous Founding

By Charles Vickers

Gives Mold Material

We have developed a copper-aluminum alloy, and are thinking about casting it in permanent molds. Can you suggest a suitable composition for the mold material?

Copper-aluminum alloys such as aluminum bronze are being poured into cast iron molds with success. The iron should be close grained, and low in phosphorus. The silicon content will depend upon the thickness of the mold, being higher for thin sections and lower for heavier sections. If the average mold thickness is around ½-inch, the silicon content will be from 2 to 2.25 per cent. The proper silicon content also will depend upon the raw materials used, cupola practice, whether machinability is desired, etc.

Q & A

Corrosion Will Occur

We have been instructed to attach cast bronze to wrought iron, using bronze bolts. All the work will be exposed entirely to the weather with the wrought iron protected with two coats of paint. Our contention is that the bronze bolts with the wrought iron will create a chemical action which will disintegrate the bolts rapidly.

In the electrochemical series of the elements iron is more positive than copper, and when the two metals are in contact in an electrolyte, galvanic action occurs. The action causes an attack on the more positive of the two metals which in this case is the iron and not the copper or bronze. Hence, you need not worry about the bolts, but rather about the wrought iron at points in contact with the bronze. However, the action under ordinary atmospheric conditions will proceed quite slowly particularly when the wrought iron is protected with two coats of paint.

In relation to corrosion a wrought iron fence set in stonework with lead caulking may be mentioned. The fence is at least 75 years old, and the original wrought iron which was about ¾-inch square has corroded to about ¼-inch square where it is caulked with lead. Since it took about 75 years to accomplish corrosion, you can see that the action is slow.

While we do not know what alloy you are going to use for the bolts, one containing 90 per cent copper, 5 per cent tin, and 5 per cent phosphor-tin containing 5 per cent phosphorus is suggested. Another excellent corrosion resisting bronze contains 94.4 per cent copper, 4.5 per cent silicon and 1.1 per cent manganese which is purchased in ingot form.

Q & A

Should Change Molding

We are having difficulty in making brass castings and we are sending you two samples. One is a piece of stick brass, and the other is cut off the end of a bushing. The stick brass which is ¾-inch diameter broke in the lathe, and appears all filled with oxide, while the bushing is a mass of blowholes on the inside where it was turned off. The bushing was 4 inches inside diameter and 5 inches outside, by 12 inches long, and the stick brass was also 12 inches long, and they were both molded on end bottom gated. The sand is No. 00 Albany. The metal was melted in a coke-fired, pit furnace, natural draft. The bushing core was made of lake sand mixed with core oil in the ratio of 40 to 1, and blacked with plumbago, mixed with glutrin.

We understand that the stick brass was molded vertically, and that it was poured that way. We believe that you will have more success in the case of stick brass, if you mold it horizontally instead of vertically. Have enough patterns to fill a flask and make a match. In the case of 1-inch diameter bars, one gate cross the end of the flask is enough. Put the runner in the cope and make it high enough to extend above those portions of the bars in the cope. Tilt the flask in pouring and get the metal hot in the furnace, using to a 100-pound pot, 1½ ounces of phosphor copper, 5 minutes before pulling out. Pour about 2200 degrees Fahr. and there will be little trouble with the stick brass.

In the case of the bushings you will note that the outside of the bushing in contact with the molding sand is sound. The porosity is all on the side next to the core. It is a certainty therefore, that the core is at fault. The molten metal will not lay on the core, because it gives out gases as it burns and that shows the core is too hard. Make the vent 1-inch in diameter, and soften up the core so that the gases evolved will pass through its structure into the vent instead of into the metal. Use molasses water to mix the blacking.

Q & A

Recovers Alloy Chips

We obtain a considerable quantity of aluminum alloy chips from our machine shop that we would like to remelt and cast into pigs. We have tried to do that without a great deal of success, and notice that the charge gets so hot that it almost melts the crucible. We have tried covering the chips with salt which seems to protect the chips until they are stirred, and then the same trouble with heat appears. Can you tell us how to obtain a good recovery?

Aluminum has an extreme degree of affinity for oxygen and where a large surface is exposed to a high temperature as in the case of melting the chips, a rapid reaction accompanied by the evolution of considerable heat occurs as you have observed. That reaction is the basis for the well known thermit process which employs metallic aluminum powder and a metallic oxide. When the mass is ignited, the metallic oxide is converted to a metal, and the aluminum is oxidized to an aluminous slag.

To obtain a good recovery it will be necessary to have the chips as clean as possible. All the oil should be removed, and that usually requires the use of centrifugal washers or dryers. The chips also should be passed over a magnetic separator to remove any iron. If you desire to melt nothing but chips, place a small quantity of the cleaned chips in the bottom of a crucible, and cover with a zinc chloride flux. Place in the furnace and melt the chips down into a small heel. Then add the chips in small quantities at a time, poking them under the surface of the molten metal. Do not add any more chips at any one time than the molten metal can dissolve without freezing. As the heel of molten metal increases in size, more chips can be added. Repeat the process until the crucible is nearly full of molten metal. Stir well, skim and pour into pigs.

Causes and Prevention of Pinholes in Aluminum Castings

By D. Hanson and I. G. Slater

SULPHUR, selenium and tellurium form compounds with aluminum which are stated to be insoluble in liquid aluminum. They also form fairly stable hydrides by direct union of the elements. The boiling point of sulphur is 444 degrees Cent. (831 degrees Fahr.) and that of selenium 680 degrees Cent. (1256 degrees Fahr.)

It appeared possible that additions of these elements to aluminum melts containing dissolved gases would disturb the equilibrium between the melts and the gas held in solution. Additions of quantities up to 1 per cent of the three elements were made to 3-pound melts of the various aluminum alloys.

Sulphur was added in the form of the ordinary commercial lump. Three or four grams at a time were stirred into the melt held at 750 degrees Cent. (1382 degrees Fahr.) by an inverted crucible mounted on a steel rod. Bubbles of gas, accompanied by the flame of burning sulphur were evolved freely during treatment. The melts were allowed to cool to 700 degrees Cent. (1292 degrees Fahr.) before casting.

Reduce the Density

A considerable quantity of dross was found which was yellow while hot, and turned gray on cooling. On casting, and just before solidification, a considerable evolution of gas from the metal occurred, which is indicative of a probable unsound ingot. Particulars of the treatments made are given in Table X. The addition of 1 per cent sulphur under these conditions results in the production of a bad pinholed casting having a reduced density.

Vitreous selenium was added to 3-pound melts in a manner exactly similar to that used for sulphur. A less vigorous reaction ensued on making the additions. Fumes varying with their density from green to reddish-brown violet were evolved from the melt. These fumes were found to have an objectionable physiological action. No gas was evolved from the ingots on casting and the treatments are given in Table XI.

Appearance of ingots in 3L11 (8 copper) and Y (4 copper, 15 magnesium and 2 nickel) alloy treated with selenium is distinctly better than that of untreated metal, although an improvement in density is shown only with the Y alloy. The pinholes in these ingots, on examination under the microscope, are found to be small, elongated, and angular.

Metallic tellurium was added in a manner similar to that used for sulphur and selenium. No reaction accompanied the addition, but, on stirring, a gritty slag was found at the bottom of the crucible. Melts treated with tellurium were stirred vigorously to incorporate the apparently insoluble compound formed. Treatments were carried out as shown in Table XII, the ingots being cast at 700 degrees Cent. (1292 degrees Fahr.).

A marked improvement with Y alloy and with 2L5 (13.5 zinc, 2.75 copper) alloy, was observed both in density and appearance. The appearance of the 3L11 (8 copper) alloy also was improved visually, due to the marked reduction in the size of the pinholes; the density of the treated 3L11 alloy was in most cases, less than that of untreated metal.

In view of the fairly promising results obtained in the case of melts treated with tellurium, and the simplicity of its application, it was decided to investigate the properties of the treated alloys further. A spectrographic examination was made by D. M. Smith, British Nonferrous Metals Research association, to determine the presence or segregation, if any, of tellurium in the ingot, and also tensile tests were made on chill and sand-cast bars.

The following were examined: 3L11 alloy—no treatment; 3L11 alloy—addition of 1 per cent tellurium; 3L11 alloy—addition of 0.1 per cent tellurium; 3L11 alloy—addition of 1 per cent selenium, and 3L11 alloy—addition of 0.1 per cent selenium. Three test samples were taken from each ingot, being cut on the vertical and longest axis of the casting, from the top, center, and taper edge respectively. The presence of tellurium was observed only in the one specimen, from an ingot to which 1 per cent tellurium had been added.

Melts of M. 3L11 alloy and Y alloy were treated with various percentages of tellurium under conditions identical with those described previously. The addition of selenium to the 3L11 alloy also was made. Four test-bars were cast from each melt, two in skin-dried green-sand molds 1.125-inch diameter x 6 inches long (*S*) and two in hand warmed chills 1-inch diameter x 6 inches long (*C*). The test-bars were turned down to a test diameter of 0.564-inch on a gage length of 2 inches and broken. The yield-point was determined by visual observation, using dividers, a method which does not give highly satisfactory results with these alloys. A summary of the results obtained is given in Table XIII.

Shrinkage May Be Factor

Tellurium and selenium are seen to have a deleterious effect on the tensile properties of sand-cast bars in 3L11 alloy, the ultimate strength being reduced by some 40 per cent. This reduction in strength accompanies the addition of only 0.1 per cent tellurium, and remains practically unaltered for further amounts. The effect on the chill-cast bars is relatively small and inappreciable. Y alloy appears to suffer no deterioration in tensile properties by the addition of 0.25 per cent tellurium, either in the sand-cast or in the chill-cast bars.

It has been suggested that shrinkage during solidification might be an important contributory factor in the production of pinholes in the castings. With the taper casting used, cooling commences more or less equally from all faces, with the re-

Loses Strength

SINCE sulphur, selenium and tellurium form compounds with aluminum, it was thought that incorporations of those elements might disturb the metal-gas equilibrium and cause elimination of the gases. Slight improvement was noted with tellurium, but it was accompanied by a loss in physical properties. This article is abstracted from a paper presented at the September, 1931, meeting of the Institute of Metals.

sult that the final areas to solidify are surrounded completely by solid metal already possessing some degree of rigidity, which would tend to oppose the progressive contraction of the still liquid and cooling portions.

An attempt to produce progressive solidification from the taper end upward, and thus eliminate effects of solidification shrinkage, was made by the use of a heavy cast-iron dozzle heated to redness and placed symmetrically on the top of the mold immediately before casting. The dozzle was 6 inches in diameter and 4 inches thick, pierced with a hole tapering from 2 to 1½ inches.

Virgin aluminum ingot and 3L11 alloy were melted and cast at 700 degrees Cent. (1292 degrees Fahr.) without treatment. The results of these experiments are given in Table XIV. The use of a dozzle appears to have little effect on the production of pinholes, resulting in slightly less satisfactory results, which may be due to the metal cooling more slowly under these conditions.

Table X

Results of Sulphur Treatment

Ingot No.	Material	Treatment—Addition of: Degrees Centigrade	Density	Appearance
93	M. 3L11	1 per cent sulphur at 750	2.764	Very unsound.
94	M. 3L11	1 per cent sulphur at 900	2.737	Very unsound.
95	M. Si	1 per cent sulphur at 750	2.573	Very unsound.
96	M. 2L5	1 per cent sulphur at 750	2.848	Very unsound.

Other Causes Responsible

Although in general the size of the pinholes in the test castings appear to be at a maximum at the center of the ingot, some large cavities were observed usually near the edges. These are particularly noticeable in the sounder ingots, as visual examination will show. It is scarcely probable that these are normal pinholes, and it is thought that they are due to other effects.

Similar cavities have been observed in chill-cast aluminum alloy ingots, which although pinhole-free in the center, show these subcutaneous cavities. In view of the well-marked effect of steam, it was thought that these might be due to reaction of the alloy with moisture given off by the surface of the mold.

In the laboratory experiments reported upon previously, skin-dried green-sand molds were used. The depth of the dried area of sand in such molds is quite small, the remainder of the sand still retaining the 5 to 10 per cent of moisture originally present. A possibility arises that water vapor from this damp sand after casting will react with the still liquid metal in the mold and will give rise to unsoundness similar to that obtained in the water-vapor experiments.

Table XI

Effect of Selenium Additions

Ingot No.	Material	Treatment—Addition of: Degrees Centigrade	Density	Appearance
100	M. 3L11	1 per cent selenium at 750	2.781	Several very small pinholes.
101	M. 3L11	0.1 per cent selenium at 750	2.786	Several very small pinholes.
102	M. Y	1 per cent selenium at 750	2.726	Several very small pinholes.
103	M. Y	0.1 per cent selenium at 750	2.718	Several very small pinholes.
105	M. Si	0.1 per cent selenium at 750	2.600	Few large pinholes.
106	M. 2L5	0.1 per cent selenium at 750	2.864	Several large pinholes.

Some stove-dried molds were prepared and castings in M. 3L11 poured at 700 degrees Cent. (1292 degrees Fahr.), with the following results: No. 17, skin-dried, density, 2.810; No. 40, stove-dried, density, 2.819, and No. 43, stove dried, density, 2.817.

Use of a completely dried mold appears to effect a slight increase in density. In view of the results it was decided to include stove-dried molds in further tests. This was carried out in the works experiments using 60-pound experimental melts. As indicated in Table VII no regular or appreciable difference in density between castings poured in the green-sand and the stove-dried molds is apparent, but the experiment is scarcely conclusive, as normal stove-drying undoubtedly will leave a considerable amount of adsorbed or combined water in the sand. Further experiments are required to test the validity of the hypothesis.

The size, number, and shape of the pinholes which occur in the 3L11 alloy (8 per cent copper-aluminum) depend on the melting conditions, treatment, when molten, and the casting conditions to which the metal is subjected. Two of the castings were taken for examination in more detail, microsections being cut from No. 5 ingot (stock 3L11 alloy melted in electric furnace and cast at 700 degrees Cent.), (1292 degrees Fahr.) and from No. 8 ingot (stock 3L11 alloy melted in electric furnace and heated to 700 degrees Cent. (1292 degrees Fahr.), when a brisk stream of steam was bubbled into the melt for 3 minutes.

Contain Abrasive Particles

Microsections were prepared in the usual manner for this type of alloy, but complete elimination of scratches, especially from the vicinity of the pinholes, was found to be practically impossible, due apparently to the secretion of coarse particles of abrasive from earlier operations in these areas, which no amount of washing and scouring seemed to remove. For etching, an aqueous solution containing 2 per cent hydrofluoric acid and 25 per cent nitric acid was used.

Pinholes are found to vary from ill-defined cracks and voids occurring in the areas normally occupied by the $CuAl_2$ eutectic, to cavities generally

Table XII

Tellurium Added to Aluminum

Ingot No.	Material	Treatment—Addition of: Degrees Centigrade	Density	Appearance
86	M. 3L11	1 per cent tellurium at 750	2.800	Very small pinholes. Moderate.
97	M. 3L11	0.5 per cent tellumium at 750	2.804	Very small pinholes. Few.
98	M. 3L11	0.25 per cent tellurium at 750	2.791	Very small pinholes. Moderate.
90	M. 3L11	0.1 per cent tellurium at 750	2.797	Very small pinholes. Several.
84	M. 3L11	1 per cent tellurium at 800	2.817	Very small pinholes. Moderate.
85	M. 3L11	1 per cent tellurium at 900	2.807	Very small pinholes. Moderate.
91	M. 2L5	1 per cent tellurium at 750	2.911	Few small pinholes. Extensive contraction cavities.
99	M. 2L5	0.1 per cent tellurium at 750	2.933	Few small pinholes. Extensive contraction cavities.
87	M. Si	1 per cent tellurium at 750	2.589	Few large pinholes.
104	M. Si	0.1 per cent tellurium at 750	2.590	Several large pinholes.
89	M. Y	1 per cent tellurium at 750	2.738	Very small pinholes. Practically sound.
92	M. Y	0.1 per cent tellurium at 750	2.730	Very small pinholes. Practically sound.

of an irregular spherical shape up to 1 millimeter or more across. Examination of the larger pinholes under the lower-power binocular microscope showed that these cavities have a regular cell-like formation, the bounding walls being formed of the aluminum-rich constituent standing in relief surrounded by darker rings of the $CuAl_2$ eutectic, similar in formation to the normal microstructure. It is to be observed that pinholing follows the crystallization of the eutectic at the grain boundaries, but bears no general relationship to grain size, except where the latter is small.

Micrographs taken at 50 diameters, show that whereas with the untreated ingot (No. 5) the pinholing follows and continues with the crystallization of the eutectic, with the alloy treated with steam for 3 minutes (No. 8) the pinholes are much larger, occur independently, and do not spread with the crack-like formation.

Gas Is Liberated

Reason for this difference in structure must be sought for in a consideration of the influence of the amount of gas liberated on solidification in the two melts. This is a function of the amount of gas held in solution in the melt and its decrease in solubility with fall in temperature. Whether voids would, or would not, occur at eutectic and grain boundaries in a gas-free melt is a matter difficult to determine.

There will be present a state of stress at these areas due to contraction on solidification, since with the casting under consideration, solidification commences more or less equally and simultaneously from all faces. Gases evolved during solidification, and not escaping from the melt, naturally will segregate with the still liquid portions—namely, with the eutectic at grain boundaries—and when present in sufficient quantity will be associated with a visible intereutectic crack.

The greater the amount of gas evolved the larger will be the crack, and should its quantity be sufficient to assume an appreciable positive pressure, the void created may be expected to assume a more approximate spherical shape. Thus, when small quantities of gas are thrown out of solution on solidification, the voids obtained will be of the crack-like intereutectic type. With large evolutions of gas, well-defined spherical cavities will result.

In the light of this argument, it may be concluded that sufficient gas has been evolved on solidification with the No. 8 ingot to create quite a considerable positive pressure resulting in the well-defined spherical cavities observed.

Conclusions derived from results obtained are: Water vapor, either in the furnace atmosphere or bubbled into the molten alloy, is found to be deleterious, rapidly giving rise to extensive pinholing and unsoundness.

Treatment with dry nitrogen or chlorine usually will effect an improvement in soundness. A mixture in equal proportions of the two gases gives results superior to those obtained by either of the gases used separately, or consecutively.

The temperature at which the melt is treated is found to be an important factor. The most satisfactory results are obtained at temperatures just above the melting point of the alloy.

A gas treatment with the chlorine-nitrogen mixture at a temperature of 700 degrees Cent. (1292 degrees Fahr.) or below for a period of 10 minutes effectively will remove all visual pinholing and unsoundness from a 3-pound melt in the electric furnace.

Works scale experiments using a 60-pound charge in an oil-fired plumbago crucible yield results which agree well with the laboratory experiments.

With 300-pound melts in a gas-fired furnace it is found that fairly satisfactory results are obtainable when the temperature does not exceed 700 degrees Cent. (1292 degrees Fahr.). On heating to a pouring temperature of 760 degrees Cent. (1400 degrees Fahr.) and continuing the gas treatment (chlorine and nitrogen) much less satisfactory results were obtained. It would appear that at these temperatures, with gas-fired melting pots, the rate of deterioration of the metal due to the absorption of furnace gases is more rapid than the beneficial action of the chlorine and nitrogen treatment.

Treatment of a 3-pound melt with titanium tetrachloride in the electric furnace is found effective in reducing grain-size. With Y alloy the treatment has removed practically all pinholing originally present, but has been less effective with the 12 per cent silicon alloy, 2L5 alloy, and 3L11 alloy—the last two showing least improvement. Much fume is evolved from the melt unless the rate of addition of the liquid titanium tetrachloride is suitably slow.

Heat in Electric Furnace

By heating 2L5 alloy at 950 degrees Cent. (1742 degrees Fahr.) in the electric furnace and stirring vigorously, so that some of the zinc vaporizes, a casting can be obtained practically free from pinholes. The addition of up to 1 per cent cadmium to a melt held at a temperature above the boiling point of cadmium is not similarly effective.

Sulphur, selenium, and tellurium are insoluble in aluminum, and can form hydrides by direct union of the elements. Quantities of these elements up to 1 per cent have been added to 3-pound melts. Sulphur gives rise to increased unsoundness. With selenium and tellurium the results obtained were irregular; in some instances an appreciable improvement in soundness was noted. These elements have a deleterious effect on physical properties, especially of sand-cast bars in the 3L11 alloy.

It has been observed that, in lab-

Table XIII

Summary of Results Obtained

No.	Alloy	Treatment	Tensile Tests: Yield Point lb./sq. in.	Tensile Tests: Ultimate Strength lb./sq. in.	Elongation per cent on 2 in.
108C	3L11	None.	12,186	24,550	5
108C	3L11	None.	16,486	22,240	3
108S	3L11	None.	9,318	16,486	2½
108S	3L11	None.	11,200	16,486	1
109C	3L11	1 per cent tellurium.	.....	22,240	4
109C	3L11	1 per cent tellurium.	11,290	22,042	4
109S	3L11	1 per cent tellurium.	7,795	10,752	1
109S	3L11	1 per cent tellurium.	7,168	10,394	1
110C	3L11	0.1 per cent tellurium.	6,451	23,744	3½
110C	3L11	0.1 per cent tellurium.	7,526	26,432	5
110S	3L11	0.1 per cent tellurium.	9,408	11,827	1½
110S	3L11	0.1 per cent tellurium.	8,960	10,304	1
111C	3L11	0.5 per cent tellurium.	12,275	22,240	3
111C	.....	0.5 per cent tellurium.	.....	.....	..
111S	3L11	0.5 per cent tellurium.	9,498	10,573	2
111S	3L11	0.5 per cent tellurium.	8,960	10,931	1½
112C	3L11	0.2 per cent tellurium.*	11,827	17,024	3
112C	3L11	0.2 per cent tellurium.*	12,365	17,920	2
112S	3L11	0.2 per cent tellurium.*	3,584	9,498	1
112S	3L11	0.2 per cent tellurium.*	8,960	10,125	2
113C	Y-alloy	None.	17,920	23,027	2
113C	Y-alloy	None.	18,816	23,834	2
113S	Y-alloy	None.	13,709	21,862	2
113S	Y-alloy	None.	15,232	21,952	2
114C	Y-alloy	0.25 per cent tellurium.	16,397	23,296	2½
114C	Y-alloy	0.25 per cent tellurium.	16,128	21,325	2
114S	Y-alloy	0.25 per cent tellurium.	19,712	23,117	2
114S	Y-alloy	0.25 per cent tellurium.	19,712	23,386	2
115C	3L11	0.25 per cent selenium.	10,752	16,800	4
115C	3L11	0.25 per cent selenium.	8,960	22,758	4
115S	3L11	0.25 per cent selenium.	9,856	11,648	1
115S	3L11	0.25 per cent selenium.	7,616	12,365	1

*Tellurium introduced via a tin-tellurium alloy containing 33 1/3 per cent tellurium.

oratory experiments, castings poured in stove-dried molds have a slightly higher density than those poured in skin-dried green-sand molds.

The appearance of larger cavities near to the edges of aluminum castings has been noted. These cavities do not appear to be normal pinholes.

Metallographic examination of test castings in the 3L11 alloy has provided information regarding the variations in character, size, and shape of pinholes in variously treated melts.

This is the third and concluding article on the causes and prevention of pinholing in aluminum sand castings. The second appeared in the Feb. 15 issue.

—THE EDITORS

Table XIV

Effect of Using a Dozzle

Ingot No.	Material	Treatment	Density	Appearance
17	M. 3L11	Standard test ingot	2.810	Moderate pinholing.
30	M. 3L11	Cast 700 degrees Centigrade. Dozzle heated to 750 degrees Centigrade.	2.790	Slightly worse.
33	M. 3L11	Cast 700 degrees Centigrade. Dozzle heated to 950 degrees Centigrade.	2.791	Slightly worse.
12	Virgin aluminum ingot.	Standard test ingot	2.673	Practically sound.
31	Virgin aluminum ingot	Cast 700 degrees Centigrade. Dozzle heated to 750 degrees Centigrade.	2.665	Slight unsoundness

Chicago Foundrymen Discuss Furnaces

Melting practice and results obtained from the operations of powdered fuel fired rotary type furnaces in production of cast metals were outlined in an address before the Chicago Foundrymen's club, Feb. 4, at the City club, Chicago, by D. W. Reese, Whiting Corp., Harvey, Ill. While covering experimental and actual production work of rotary furnaces in Europe and this country, Mr. Reese particularly described results and performance of the Brackelsberg furnace his company installed in Birmingham, Ala.

Practicability of this furnace, a 2-ton unit, in producing sugar plant retort castings, and the relation of the rotary furnace to cupola metallurgical practice, costs, fuel, linings, charging, carbon control, temperatures and labor were among the factors emphasized.

Mr. Reese suggested the use of the rotary furnace as an auxiliary or duplex unit for the gray iron foundry, stressing its ability to produce castings of high transverse and tensile strength, metal relatively free from slag, light oxidation, heat and corrosion resistant iron and various alloy grades. In describing the methods of direct pulverized coal firing, or by central plant system, Mr. Reese pointed out the necessity for care of the coal and the relatively cheap fuel that is adaptable. The rotary furnace unit, he pointed out, fits any foundry layout.

The lining used in the Alabama furnace is a silica lining made of ¼-inch mesh ganister bonded with 10 per cent fireclay. The 30 degree tilting of the furnace in charging results in a minimum of damage to the monolithic linings when the furnace is hot. Little carbon is lost in melting, the Alabama furnace practice providing 2.25 per cent carbon for a tensile strength of 43,000 to 45,000 pounds. Silicon lost in melting is found to be light when preheating of primary air is practiced, but preheating is not general in rotary performance in this country. Loss in manganese is found similar to cupola practice. The melting rate of 1 to 2½ tons an hour was found to depend upon the firing rate. While up to 30 per cent borings and turnings may be charged, use of 15 per cent borings is regarded as best practice. Refractory costs were estimated at 50 cents per ton of iron, and labor, requiring no greater skill than for cupola work, costs slightly more than for cupola practice.

Pour Iron Against Chill

We shall greatly appreciate information on the proper mixture for glass house molds poured against iron chills or cores. The castings are to be used for etching, the castings themselves being etched. The iron must be machinable.

We assume from wording of this inquiry that after the castings are machined on the working areas, a design is etched on the surface to be reproduced in reverse on the glass object. A fine, close grain iron is required for this purpose and the readiest method of producing this iron is to add steel scrap to the charge and melt and pour the metal exceedingly hot.

A typical analysis for molds with 1 to 1½-inch thickness of metal is: Silicon, 1.75 per cent; sulphur, under 0.10 per cent; phosphorus, 0.20 to 0.30 per cent; manganese, 0.70 to 0.80 per cent; carbon, 3.30 per cent. Iron of the foregoing analysis when poured against a light chill, will show a slightly chilled surface, but will be machinable and the finished face will take a high polish. The same iron poured against a heavy chill, will chill to a greater depth and may not be machinable. As a check on this feature it is advisable to pour test blocks several times during the heat and note the depth of chill.

If you are interested in the application of alloy irons and if you have the necessary facilities for carrying on the work, you will find a great deal of valuable information in an article published in two parts in THE FOUNDRY, July 1 and 15, 1931, under the title *Outlines Method of Making High Test Gray Iron*, by L. M. Sherwin and T. F. Kiley.

There is no general, universal mixture that will suit all classes of glass house castings. The same iron will show different characteristics if poured into light castings, heavy castings, green sand molds, dry sand molds, against light chills and against heavy chills. An intimate, working knowledge of all these variables is essential to a foundryman engaged in the production of molds for glass factory use. It is a form of knowledge that can be acquired only through close personal application and observation, supplemented by study of articles on the subject in the technical press.

Reports on Accidents

With 378 reports received during the first three months of the state wide safety campaign there was an average of an accident for each 25,487 man hours worked, according to the Ohio Foundries association. Reports from 149 foundries for November, 137 for December and 92 for January show 133 foundry mishaps in 3,389,702 man hours worked. The December average is the highest with an average of 27,797 man hours per accident, while the partial report for January is lowest with an average of 23,823 man hours per accident.

Tests Soy Bean Oil

The engineering experiment station of the University of Illinois, Urbana, Ill., recently published bulletin No. 235 on "An Investigation of the Suitability of Soy Bean Oil for Core Oil," by C. H. Casberg and C. E. Schubert. Data is given on the compositions used, apparatus and methods of test employed, and the results obtained. Copies of the bulletin may be obtained for 15 cents.

Fuel Economy Engineering Co., St. Paul, has been appointed representative in the St. Paul territory for the Air Preheater Corp., Wellsville, N. Y., and will handle air preheaters and hot-blast cupola systems.

Temperature Indicators Are Calibrated Easily

By Norman F. Hindle

PHYSICAL properties of castings depend in many cases upon the heat treatment they receive. The demand for greater strength and better quality caused the development of various types of irons and steels to meet the higher specifications. Study was necessary to determine the properties of these materials. Critical points, heat treatments to give the specifications for different uses with lowest possible cost, correct pouring temperatures under varying conditions, etc., had to be determined. When the correct conditions were found, instruments were necessary to control them. Without the pyrometer the foundryman would be far behind in modern castings development.

Gives Early History

The word pyrometer is used to describe any device for determining temperatures above the upper limit of the mercury thermometer. The necessity of having an instrument that would measure temperatures in excess of 357 degrees Cent. or 672 degrees Fahr., the boiling point of mercury, led to its development. Sir Isaac Newton in 1701 was the first to attempt the determination high temperatures. He did not have much success and the subject received no further impetus until 1782 when Josiah Wedgwood, a famous potter, devised a method of determining high temperatures based on the contraction of clay at increasing degrees of heat. This method was used for about 40 years.

In 1822, John Daniell made a high temperature measuring device which consisted of a platinum rod encased in plumbago. When the rod was heated, it expanded and operated a magnifying device which moved a pointer over a scale that was divided to read directly in degrees. The same year Seebeck discovered thermoelectricity, which is responsible for the majority of commercial temperature control devices. The thermoelectric effect was not understood at that time and many theories were advanced to explain it. In 1826 Bequerel made an instrument based on that principal and Pouillet and others attempted to devise methods for its use, but they failed. Their failure was due principally to lack of accurate instruments and the method was abandoned until 1886.

In that year LeChatelier invented the first successful pyrometer based on the Seebeck effect. It was a noble metal couple with one platinum wire and the other a platinum wire containing 10 per cent rhodium. These wires were attached to a d'Arsonval or moving coil galvanometer as an indicator. This method is still the basis of temperature recording instruments. LaChatelier also was the inventor of the optical pyrometer.

Although Seebeck did not understand the laws governing the thermoelectric effect, it later was found that it was based on the principle that when two dissimilar metals are joined to form a complete circuit, if the junction and the ends of the wires are at different temperatures, an electromotive force will flow through the circuit. The voltage is small and is proportional to the difference in temperatures. This is the first law of pyrometry.

While there are many different types of pyrometers such as resistance, optical and radiation, the thermoelectric probably is the most used commercially. This article will be confined to a discussion of thermoelectric pyrometers for that reason. Thermoelectric pyrometers generally are divided into two classes, those employing noble metals, such as platinum, platinum-rhodium and platinum-irridium, and those using base metals, such as nickel-chromium; nickel - chromium - aluminum-silicon; copper-nickel and copper-nickel-iron alloys and pure iron and copper. Noble metal couples are more expensive but are capable of indicating higher temperatures than the base metal couples. They are indispensable in some cases for the latter reason. Noble metal couples are used for laboratory and calibrating purposes while the base metal couples are used for many industrial processes. According to Cork and Wood in *Pyrometry*, base metal couples are divided into four classes. The first class includes those using a 90 per cent nickel, 10 per cent chromium-alloy as the positive wire and 94 per cent nickel, 2 per cent aluminum, 3 per cent manganese and 1 per cent silicon alloy as the negative; the second contains those using pure iron as the positive wire and a 60 per cent copper, 40 per cent nickel alloy as the negative; those included in the third class use copper as the positive wire and the same negative as those in class two the last group uses a 64 per cent nickel, 25 per cent iron, 11 per cent chromium alloy as the positive lead and a 45 per cent nickel, 55 per cent copper alloy as the negative. Other alloys are used for these purposes but most of them are modifications of those just mentioned.

Close Temperature Control Is Needed

Use Different Couples

The first class of base metal couples will stand constant use over a period of several months up to a temperature of 2000 degrees Fahr. They are durable and generate a millivoltage of about 0.04 per degree Cent. The second class may be used for temperatures as high as 1800 degrees Fahr. They are subject to oxidation and contamination, so pre-

ventive methods must be used to protect them. They generate a millivoltage of about 0.055 per degree Cent. Class three may be used to measure temperatures up to 1000 degrees Fahr. and are especially useful in determining below zero temperatures. L. H. Adams, *Pyrometry Symposium*, American Institute of Mining & Metallurgical Engineers, 1920, tells of having measured—253 degrees Cent. with that type pyrometer. When below zero temperatures are being measured, it is necessary to reverse the terminals of the thermocouple as the millivoltage flows in the opposite direction. This class of couples require no protecting tube at low temperatures. The last division has the same range as those couples in class three.

Several requirements are necessary for a thermocouple to function properly, including the following: It must have only one value of electromotive force for a given temperature; the couple must have a steadily increasing voltage for a rise in temperature; the wires must be chemically and physically uniform; the temperature coefficient of resistance must be small; the couple must resist thermal, chemical and mechanical action and the wires must be low in cost and easily replaceable. Of course, it is practically impossible to secure a couple with all of these properties so the question becomes one of finding a couple which will fulfill the most important of these requirements for the purpose which it is used.

Insulating Is Important

The insulation of a thermocouple also is of importance. Chief among the properties of a good insulator are: It must withstand mechanical strain; it must withstand high temperature without melting, cracking or disintegrating; it must withstand chemical action; it must not distill contaminating gases; it must be impervious to furnace gases that might contaminate the couple; it must be a good conductor of heat and must have a low specific heat. As with thermocouple wires, all these properties are practically impossible to obtain in a single substance but the best may be selected for the purpose.

While almost any two different metals may be fused together and heated to give the thermoelectric effect, only a few have the required properties. Some give irregular curves, others deteriorate, and still others suffer an alteration in thermoelectric properties. Other combinations exhibit what is known as thermoelectric inversion. That phenomenon is evidenced in some materials which, when joined together, form an almost perfect couple up to a certain temperature where instead of the voltage increasing uniformly it diminishes and continues to decrease as the temperature rises. A copper-iron thermocouple is an example of that type. These are some of the reasons why the combination of metals that are available for commercial purposes is limited.

Base metal couples have several advantages over the noble metal couples. First is the cost. The noble metals are considerably more expensive than the base metals. Other advantages are related to methods of calibration. Noble metal couples have parabolic curves that follow the equation.

$$E = a + bt + ct^2$$

while base metal couples are made by the manufacturer in such a manner that their curve is a straight line or nearly so whose equation is

$$E = a + bt$$

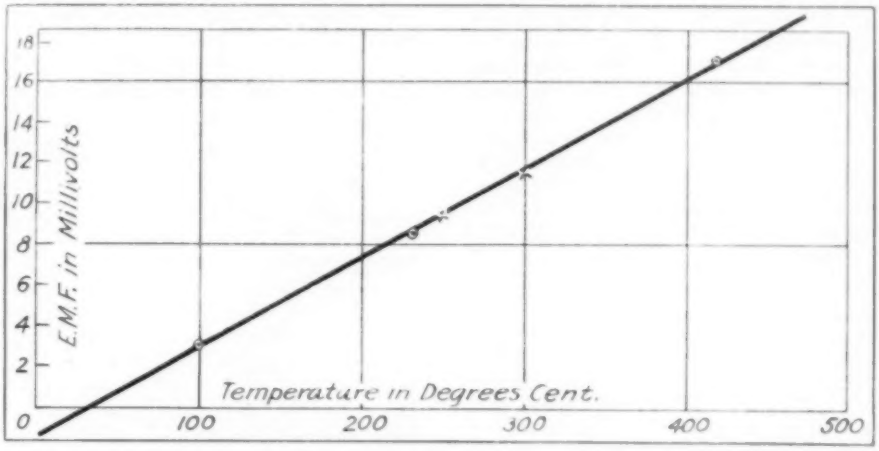
Since the base metal couples have a straight line calibration curve, only two points at widely different temperatures are necessary to calibrate them. If they have been in use and it is desired to check them, only one point is necessary. If that point does not fall on the curve, the per cent error may be assumed to be constant for commercial purposes.

Error Assumed Constant

As an illustration, assume a new thermocouple to show 1000 degrees Fahr. at that temperature and later after it has been in use for some time, it registers 980 degrees Fahr. at the previously mentioned point. The error is 20 degrees Fahr. or 2 per cent. Then at 1600 degrees Fahr. is may be assumed that the error is still 2 per cent or 32 degrees Fahr.

Another advantage of the base metal couple over the noble metal couple lies in the application of cold junction corrections. If a base metal couple is calibrated at 0 degrees Fahr. cold junction temperature and is being used at 15 degrees Fahr., 15 degrees is added to the reading obtained. If under the same circumstances of calibration the cold junction temperature is minus 15 degrees Fahr., that amount must be subtracted from the observed temperature. This method cannot be applied to noble metals since their curves are those of parabolic equations. A new curve must be made and corrections applied to each degree marked on the scale of the instrument.

Two methods are given generally as those used for the calibration of thermocouples. One is the comparison method and the other is the freezing point method. The comparison method is what the name indicates. A standard thermocouple is placed in a furnace that has been allowed to come to constant temperature with the couple that is to be calibrated. The temperature of the furnace then is raised and readings are taken at definite intervals as the temperature increases. Comparison of the temperatures indicated by the unknown couple with those shown by the standard couple give the error or correction that must be applied to give the correct temperature. Cold junctions are kept at the desired temperature which must be the same for both couples.



This Curve Would Tend To Show That Two Points Are Sufficient To Determine The Curve of a Base Metal Couple

In laboratories, couples often are calibrated by comparing the millivoltage of the couples at the same temperatures and drawing a curve for the unknown couple by plotting the millivoltage against the temperature as determined from the curve of the standard couple. In this way the temperature for any millivoltage of the unknown couple may be obtained directly by referring to its curve.

Certain precautions must be taken when using that method of calibration. If the couples are being calibrated for commercial purposes, it is the best policy to obtain as nearly the conditions under which the couple is to be used during the testing as furnace conditions often influence the readings of couples. A method that is applied in some places is to have a hole in the furnace wall close to the opening through which

the thermocouple projects into the furnace and placed in such a way that the tips of the couples will be close together when the standard is placed in the second hole. The second opening is closed when it is not in use but in such a way that it may be opened easily. The conditions of calibration and use are as nearly the same as is necessary for commercial operation.

For laboratory calibration where the highest accuracy is necessary, a groove is sawed in the unknown couple where it is fused and the standard noble metal couple end placed in the groove and the saw cut squeezed together to give good thermal contact. In this way they are kept so close together that, regardless of the flow of heat and its variation, they will be as near the same temperature as possible.

Freezes at Definite Temperature

Another method used to calibrate thermocouples is the freezing point method. It involves the determination of the freezing point of pure metals obtained from reputable sources such as tin, zinc, antimony, the boiling point of water on the freezing point of salt. It is known that these materials have the following melting, boiling, or freezing points:

Substance	Degrees Cent.	Degrees Fahr.
Water (Boiling Point)	100	212
Tin (Melting Point)	231	449.4
Zinc (Melting Point)	419	786.9
Antimony (Melting Point)	631	1167
Salt (Melting Point)	801	1474
Copper (Melting Point)	1083	1981.4

Three or more of these metals are heated to a temperature exceeding their melting points by about 50 degrees, and the thermocouple, encased in a suitable protecting tube, is placed in the molten metals one at a time. The heating of the metal is stopped and the metal then begins to cool. Readings are taken at regular time intervals and the freezing point of each of the metals is determined as being the point at which no temperature change takes place for several readings. The temperature is allowed to drop 50 degrees below that point, and the metal then is reheated. Readings are taken, and if the metal is pure, the stationary point will be the same as determined as the metal cooled, because the melting and freezing points of a pure metal are the same. These points and their millivolt readings at the temperatures being known, the equation of the curve for the couple may be determined as follows: Assume the values of the readings taken to be those given in Table I. The temperatures of the freezing points of tin and zinc would have the values 8.4 and 17.2 respectively. Boiling point of water showed 3.2. Substituting these values for E and

Table I

Data for Curve

Time Minutes	Tin Millivoltage	Zinc Millivoltage	Water Millivoltage
0	9.5	26.2	3.2
	9.0	26.7	
1	8.7	26.5	
	8.4	25.5	
2	8.4	24.5	
	8.4	23.0	
3	8.4	22.0	
	8.4	20.9	
4	8.4	20.0	
	8.4	18.8	
5	8.3	18.0	
	8.25	18.0	
6	8.2	17.2	
	8.0	17.2	
7		17.2	
		17.2	
8		17.2	
		17.0	
9		16.7	
		16.3	

the known temperatures for t in the equation

$$E = a + bt + ct^2$$

and solving the equations simultaneously, the equation becomes

$$E = -.347 + 0.0335t + 0.0000197t^2$$

To prove the equation is correct substitute other values for t in the equation and if the values for E obtained fall on the curve it may be assumed that the equation is correct. Substituting 250 degrees Cent. and 300 degrees Cent. the values of the millivoltage found were 9.3 and 11.5 respectively. These fell on the curve so it was assumed to be correct. It will be noted from the accompanying illustration that the line plotted for the equation is nearly straight. The couple used for the experiment was a base metal couple and the line shows that fact. That experiment tends to demonstrate that two points are sufficient to determine the curve of a base metal couple and that these values if substituted in the equation

$$E = a + bt$$

would give an accurate enough temperature measurement for commercial purposes.

Pure Salt Employed

Probably the simplest method used for a single point check on a thermocouple is by ascertaining the freezing point of pure salt. It is melted in an alloy iron crucible and its temperature raised beyond that point. Six or eight inches of the thermocouple then are immersed in the molten liquid and readings are taken at definite intervals as in other calibrations. The portion of the curve representing the true freezing point is reached when crystals begin to form along the entire immersed length of the thermocouple. Salt freezes at 801 degrees Cent. or 1474 degrees Fahr. A couple may be checked easily by this method. One precaution that must be taken is that when the salt is melted for the first time it should be covered because the water contained in the crystals causes it to sputter badly. After the first melting no further trouble occurs. In addition to the information presented in this article, it is suggested that the reader obtain a copy of technologic paper No. 170, *Pyrometric Practice* by Foote, Fairchild and Harrison.

Equipment Association Elects Officers

Foundry Equipment Manufacturers' association, meeting at Cleveland Feb. 5, elected the following officers: President, H. S. Simpson, National Engineering Co., Chicago; vice president, H. S. Hersey, C. O. Bartlett & Snow Co., Cleveland; directors, the foregoing and H. J. Koch, Fort Pitt Flask Equipment Co., Pittsburgh, T. W. Pangborn, Pangborn Corp., Hagerstown, Md., and R. T. Turner, Shepard Niles Crane & Hoist Corp., Montour Falls, N. Y. D. M. Avey, editor, THE FOUNDRY, Cleveland, is secretary-treasurer.

Companies Consolidate

Rockford-Northwestern Malleable Co., and the Gunite Corp., Rockford, Ill., have consolidated under the name of the Gunite Foundries Corp. Duncan F. Forbes, president and general manager of the new concern, formerly was president of both corporations. Others in active management of the new company are: J. A. Forbes; secretary and assistant to the president; Frank C. Rutz and Erwin J. Mohr; vice presidents; Noble J. Schmidt, treasurer and L. R. McCullough, advertising manager. The latter also will be sales manager of the Guncor Brake Drum Replacement division. The new corporation will continue in the production of brake drums, clutch pressure plates, connecting rods, wrenches, bolts and antifreeze solutions.

Heads Moltrup Company

Walter J. Moltrup has been elected president of the Moltrup Steel Products Co., Beaver Falls, Pa., succeeding his brother, the late J. T. Moltrup. F. F. Ward, recently vice president and assistant treasurer, has been made vice president with M. L. McGaughey, now assistant treasurer. J. L. Phillips has been re-elected secretary and treasurer.

Horace Hammond, president, Hammond Iron & Co., Birmingham, recently was elected president, Alabama By-Products Corp., Birmingham, succeeding the late Morris W. Bush.

BILL

By Pat Dwyer

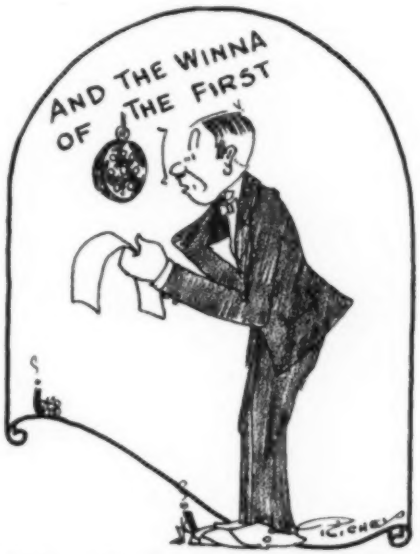
Thinks Rat Tails Caused by Steam

AT ONE time or another I have received letters on nearly every conceivable subject. Well, perhaps that statement is an exaggeration. Nearly ever conceivable subject takes in too much territory. The thought I wish to convey is that over a long period I have received a great number of letters from a great number of people on a great many different subjects and naturally I have found some of outstanding merit or demerit in the collection.

The old saying that once you have seen a circus, a parade, a picnic, a foot race, a fight or a frolic, you have seen all that possibly can be seen in that particular line, does not hold true with letters. Many letters fall into the see-one-see-'em all classification, but a considerable number vary more or less from standard. Now and again one turns up so utterly different from all others, that I read it through several times and then file it away in a special folder. Some day, I hope, some radio advertiser will offer a prize for the most atrocious example of the English language in written form. Then I shall overhaul the file, select the most promising specimen, send it to the station to which you are listening and just naturally walk away with the prize.

In a burst of generosity I mentioned this program to Bill and intimated that when the prize money arrived I would see that he was included in the general jollification which surely would follow. In the meantime I intended to look up various sources of information on how to spend easy money. You probably have noticed that there is not much fun in spending money for the essentials, for food, clothing and shelter. It is a species of bargaining in which each party involved, tries to secure a slight advantage over the other. The butcher, the baker, the candlestick maker, want all they can get for their wares. The customer wants all he can get for his penny.

None of these sordid features about the money that comes without effort. It can be spent for something that is neither of ornament or use. It can be spent for gratifying a passing whim, but irrespective of whether it is spent a little at a time, thrown away in handfulls, or burned in bundles, it leaves no ashes of regret. I fully intended to develop this theme to still greater extent—the joy of flinging away your own jack—if I have the phrase correctly—with no person to say you nay, but Bill interrupted to tell me he was not going to lose any sleep over



To Strut His Stuff Properly He Should Have a Baton, High Boots and a Shako

the prospect of helping me celebrate.

"I could give you forty reasons," Bill said, "forty good reasons why you never will receive any prize through the medium of the radio. However, I think one good reason is enough. Listen. I don't know what kind of a letter you have up your sleeve, but it can't be any worse than some of the regular messages inflicted on the public.

"Well," I admitted, "Perhaps you are right, and then again little bright eyes, perhaps you are wrong. I have some pretty good specimens in my personal file, but in this particular instance I'll show you a circular letter that could not be duplicated by any three men who set out deliberately to ignore all rules of grammar, composition and even ordinary common sense. My only regret is that I am not the original recipient of the letter. It was given to me by a citizen who knows of my collection of rare and curious manuscripts. Here—to borrow one of your own phrases—get an earful of this:

Dear Mr. Bingo:

Mrs. Bingo and the children—dear little kiddies—will, of course, no doubt, receive this Christmas as they always have heretofore, in the past received a Christmas present for each and every one, from you as a real and tangible expression of your husbandly and fatherly love, esteem and devotion.

But the most Wonderful thought is that now it is for the first time possible and you can arrange easily and have delivered to them After you have gone to that bourn from which No traveler returns, a present in the form of a Check—Can't you imagine their Joy?—at each Christmas time from their late deceased husband and father, for, and as long as they shall live, they will never forget you.

Don't you agree with me, see eye to eye with me on this point that this thoughtful and highly meritorious little act of remembrance from you before you go will make their Christmas with its many memories of all kinds, much more pleasant and possibly a tiny bit, just a little teeny-weeny bit easier to bear, for at such a time, and you know how true it is, your and my families will miss us most?

The amount of the gift, the actual cash value or what it represents in buying power, is not the Point. As of course you will be the first to admit when you think it over Calmly. Your foresighted thoughtfulness of them is really what counts in the long run. Who can tell in advance at any time, or at any other time, just what Moral influence such a thing as this little gift may have over a boy or girl of almost any age but particularly at an impressionable age, to have the loving memory of their Father, a name they never will forget as long as they live, renewed in such a Tender manner, also touching and useful manner each year at the glad Christmas time, the time for rejoicing when there Really is something to rejoice for.

The reason of this letter, and of course you are entitled to an explanation of the reason, instead of a Personal visit from me in person to your home or office, is prompted by the thought that it is altogether possible that you had much rather be alone with your own thoughts while seriously considering a matter of this important nature. It is import to you, but just think how much more important it is or will be bound to be to your loved ones, depending on how you finally dispose of this important proposition.

The average annual deposit, in other words the average annual yearly premium for the remembrance check in amount of Twenty-Five Dol-

lars ($25.00) is approximately or in the neighborhood of Twelve Dollars ($12.00). Just think! $1 a month or a trifle over three cents a day. The amount is ridiculously small when you come to think of the returns that will keep rolling in for years and years into the future.

Grand Training for Writing News Paper Serials

Larger amounts proportionately, that is to say, for a perpetual Christmas check of say $50, the annual yearly premium will be a little higher.

Just write your date of birth on the enclosed card, that's all I ask of you at the present time, and drop it in the mail. Your actual signature or any other activities on your part just now is unnecessary as your file number on the card will suffice to identify you to us.

Yours sincerely,
James Gabington,
Special Agent.

"Outside of being a little long," Bill said, "it seems to cover the ground. I suppose it could be clipped—"

"Clipped?" I exclaimed. "It could be reduced to about 100 words and then it would be too long for any place except the waste basket. Here's a revised version:

This Christmas, as usual, Mrs. B and the children will receive presents from you. You can arrange to have a check delivered every Christmas throughout their lifetime. This remembrance will be appreciated. The amount is not so important as the thoughtfulness in providing it. Memories of a father affect the character of the children. This letter, instead of a personal visit, is prompted by a reluctance to intrude while you are considering the subject. For an annual $25 check, the annual premium is approximately $12, other amounts in proportion. Write your birth date on the enclosed card and mail the card. We shall attend to all further detail.

"As a composition," Bill said, "the thing is pitifully awful. As a sales argument it is even worse. It should be reduced still farther to:

Do you want a remembrance check for any given amount sent to your family every Christmas after you have gone? Sign and mail the enclosed card. We'll do the rest.

"Now, there is a plain business offer. You can take it or leave it and you entertain none of the feeling of hostility or contempt which you entertain for the first writer with his silly letter dripping with sob sentiment, false humility and bogus sympathy.

"You will find none of that stuff in the letters I get now and again from foundrymen who are puzzled temporarily by a feature with which they are not familiar. They do not waste time telling me I am a good old scout, that I am devoted to my family and that probably I never offered violence to my parents. Not they. These lads come out frankly and say: 'Here's something that has me stopped temporarily. Probably I could work the puzzle out if I had the time. However, it is possible that you may be able to throw some light on the subject and if you are I shall be glad to hear from you.' That's all. Straightforward and to the point.

"I am equally frank in my reply. In some instances, fortunately, I am in a position to know the answer. In others I can present only a theory based on a rather extended experience and on the evidence submitted. Occasionally the question deals with a point outside my scope of knowledge and I admit cheerfully that I don't know.

"Some time ago I had a letter from a man in which he said that he was forwarding for my inspection two small stoveplate castings on a single gate. He would appreciate my opinion on the cause of the rat tails which appear on the drag face. He claimed that the cope and drag faces of the mold were examined through a microscope and apparently were in perfect condition before the mold was closed. The iron was white hot, taken directly from the cupola at the seventh round.

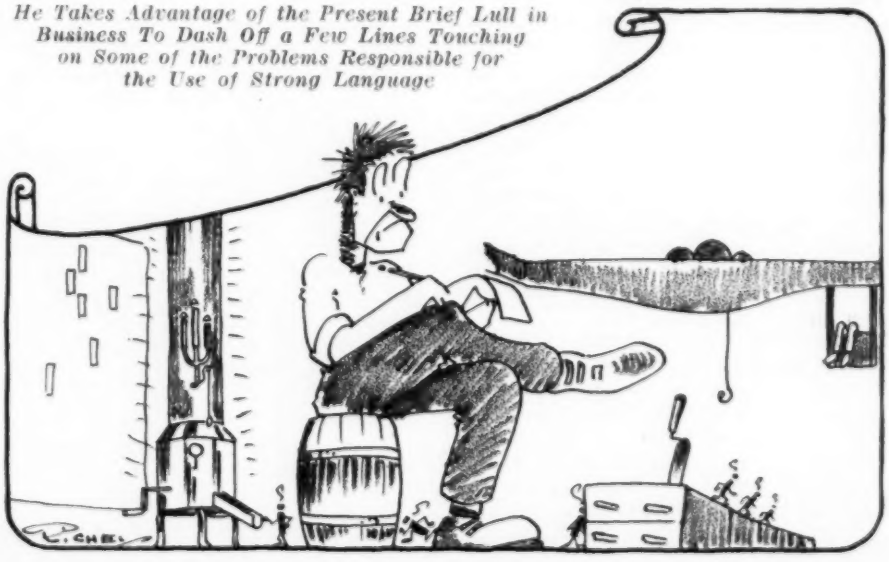
"The direct cause of rat tails on stove plate is one of the questions that still is in the controversial class. The fact that they appear and disappear at irregular intervals with apparently no change in the materials or methods often has caused foundrymen to wonder whether the situation was improved through the remedy adopted or in spite of it. The following theory was submitted for what it is worth.

"Rat tails are caused by a slight film which precedes the flowing stream of iron as it spreads over the face of a mold. The film may be due to any one of several causes, but usually it may be traced to sand that is a little damper than necessary. The steam that is generated carries fine dust in suspension and this remains after the steam has evaporated on the face of the mold in ridges along those irregular lines where the iron streams have met.

"In the casting submitted I am inclined to the opinion that the swab was used too freely around the bottom of the gate in the cope. The sand is all *boiled* away at the point where the upright runner joins the gate and small particles of sand together with steam cavities have been exposed by the sandblast on the upper face of the flat gate.

"The obvious remedy is to work the sand as dry as possible and this naturally involves close inspection and the active cooperation of the molders. The claim has been advanced at times that a small quantity of lime added to the facing sand will prevent rat tails. This may be true, but it probably is owing to the fact that lime serves as a drying agent. Either wet sand or dry sand will cause trouble in a mold and a high degree of skill is required to prepare and maintain sand within

He Takes Advantage of the Present Brief Lull in Business To Dash Off a Few Lines Touching on Some of the Problems Responsible for the Use of Strong Language



the narrow range of limitation where it will serve satisfactorily. It is claimed rat tails never were found on castings gated on top."

Study Brass Losses

The department of engineering research, University of Michigan, Ann Arbor, Mich., recently has published bulletin No. 22 which is entitled "The Effect of the Products of Combustion on the Shrinkage of Metal in the Brass Industry," by C. Upthegrove and A. J. Herzig. The shrinkage referred to is the metal loss during melting. The authors investigated volatilization losses in various atmospheres with varying rates of flow through the furnace, and the application of fluxes. The results presented are of interest to all foundrymen melting brasses. Copies of the bulletin may be obtained for $1 each from the department of engineering research.

Reader's Comment

Editor's Note—Material appearing under this head does not necessarily reflect the opinion of THE FOUNDRY or of its editors.

TO THE EDITORS:

On page 32 of the Feb. 15 issue of THE FOUNDRY in reply to a question regarding "Make Radiator Castings," the following statement is made: "Metal patterns, split along the center line are mounted on stripping plates and are dropped a short distance before the cope or drag is lifted away."

Having recently designed radiator molding equipment for a number of manufacturers, I wish to advise that practically none of the standard tubular radiator sections are made on stripping plates. The split patterns are mounted on solid pattern plates. These pattern plates are mounted on molding machines which lift the flask with its mold off of the pattern and at the same time push the chaplets out of the holes in the split pattern in which the chaplets are inserted.

SHERWOOD C. BLISS,
Industrial Engineer.

Kenmore, N. Y.

St. Louis Group Meets

Granville A. Waters, chief electrical engineer, Wagner Electric Co., St. Louis, spoke on "Where the Foundryman Can Be of Service to His Customer" and William A. Crutcher, Air Reduction Sales Co., St. Louis, demonstrated the use of liquid air at the regular January meeting of the St. Louis District Foundrymen's club. Special entertainment also was provided under the direction of Freeman Culver, chairman of the entertainment committee. Approximately 60 members and guests attended the meeting, held in the American Annex.

DIRECTORY OF FOUNDRY ASSOCIATIONS

American Foundrymen's Association

President, E. H. Ballard, General Electric Co., West Lynn, Mass.; executive secretary-treasurer, C. E. Hoyt, 222 West Adams street, Chicago; technical secretary, R. E. Kennedy, 222 West Adams street, Chicago.

Associated Brass Founders of New England

President, George W. Thornburg, Crescent Park Brass Foundry, Waltham, Mass.; secretary, Herbert H. Klein, Pennsylvania Foundry Supply Co., 310 Congress street, Boston. Meetings the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen

President, J. McArthur, Washington Iron Works; secretary, W. J. Wark, E. J. Woodison Co., 140 Chandler street. Meetings each month at club rooms, 140 Chandler street.

Central Illinois Foundrymen's Club

President, H. M. Hire, Hire Foundry Co., Peoria, Ill.; secretary, Franklin Whitehead, The Meadows Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club

President, L. E. Gilmore, Crane Co., Chicago; secretary, Albert N. Wallin, S. Obermayer Co., 2563 West Eighteenth street. Meetings first Thursday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association

President, Carl S. Neumann, Union Mfg. Co., New Britain, Conn.; secretary, Charles S. Parker, Charles Parker Co., Meriden, Conn. Meetings are on second Friday of each month in various parts of the state.

Connecticut Nonferrous Foundrymen's Association

President, C. H. Blanchard, Reading Steel Casting Co., Pratt & Cady division, Hartford, Conn.; secretary, C. D. Elliott, Wilcox, Crittenden Co. Inc., Middletown, Conn. Meetings held the first Monday of each month at place to be named. Recent meetings have been held at Hotel Garde, New Haven, Conn.

Detroit Foundrymen's Association

President, James L. Mahon, American Car & Foundry Co.; secretary, Neil I. McArthur, Great Lakes Foundry Sand Co., 2100 Penobscott building, Detroit. Meetings third Thursday in each month, except December, June, July and August at Ft. Shelby Hotel.

East Bay Foundrymen's Association

Secretary, O. R. Moller, Electric Steel Foundry Co. Inc., 1328 Second street, Berkeley, Calif.

Electric Steel Founders' Research Group

Director, R. A. Bull, Central Office, 541 Diversey Parkway, Chicago.

Gray Iron Institute

President, A. E. Hageboeck, Frank Foundries Corp., Moline, Ill.; manager, Arthur J. Tuscany, 4300 Euclid avenue, Cleveland.

Malleable Club of Milwaukee

President, Scott Mackay, University of Wisconsin, Madison, Wis.; secretary, M. A. Harder, Lakeside Malleable Iron Co., Racine, Wis. Meetings second Tuesday of the month at Hotel Blatz, Milwaukee.

Malleable Iron Research Institute

President, E. E. Griest, Chicago Railway Equipment Co., Chicago; secretary, Robert E. Belt, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association

President, William Ember, Jefferson Brass Foundry, 62 Delevan street, Brooklyn, N. Y.; secretary, William E. Paulson, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 2 Park avenue, New York.

New Jersey Foundrymen's Association

President, W. H. Mantz Atlas Foundry Co., Irvington, N. J.; secretary, G. W. Hannay, Barnett Foundry & Machine Co., Irvington, N. J. Meeting called by president. Scheduled meeting dates: Oct. 28, Dec. 2, Jan. 27, 1932, March 23, 1932, May 25, 1932.

New England Foundrymen's Association

President, LeRoy M. Sherwin, Brown & Sharpe Mfg. Co., Providence, R. I.; secretary, Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass. Meetings held the second Wednesday of each month excepting July and August at the Engineers club, 2 Commonwealth avenue, Boston. Outings usually are held in the months mentioned.

Ohio Foundries Association Inc.

President, A. H. Kramer, Advance Foundry Co., Dayton, O.; secretary, Robert Hoierman, 418 Penton building, Cleveland.

Pacific Coast Founders Association

President, Charles J. P. Hoehn, Enterprise Foundry Co., 2902 Nineteenth street, San Francisco; manager, S. M. Truitt, Room 320 Rialto building, San Francisco.

Philadelphia Foundrymen's Association

President, J. B. Greenstreet, Olney Foundry Co., Philadelphia; secretary, Earl Sparks, 1623 Sansom street, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Pittsburgh Foundrymen's Association

President, H. F. Siefert, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; secretary-treasurer, William J. Brant, Wm. J. Brant, Bessemer building, Pittsburgh. Meetings on the third Monday of the month, except in July and August at Fort Pitt hotel.

Quad-City Foundrymen's Association

President, E. A. Gullberg, Union Malleable Iron Works, East Moline, Ill.; secretary-treasurer, J. P. Broaden, Union Malleable Iron Co., East Moline, Ill. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

St. Louis District Foundrymen's Club

President, W. C. Raithel, Century Electric Co., St. Louis; secretary-treasurer, Leo J. Filstead, John C. Kupferle Foundry Co., St. Louis. Meetings the fourth Thursday of the month at 6:30 p. m., at the American Annex hotel, Sixth and Market streets, St. Louis.

Southern Metal Trades Association

President, John S. Schofield, J. S. Schofield's Sons Co., Macon, Ga.; secretary, W. E. Dunn Jr., Hurt building, Atlanta, Ga.

Steel Castings Development Bureau

Research Director, George Batty, 500 Stock Exchange building, Philadelphia.

Steel Founders' Society of America

President, Arthur Simonson, Falk Corp., Milwaukee; managing director, G. P. Rogers, Graybar building, New York.

Tri-City Technical Council

Chairman, C. F. Scherer, Davenport Machine & Foundry Co., Davenport, Iowa; secretary, E. C. Xander, assistant secretary, Tri-City Manufacturers association, Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association

President, William Hoppenjans, The Star Foundry Co., 221 Main avenue, Covington, Ky.; secretary, C. C. Erhart, Chris Erhart Foundry Co., Cincinnati. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association

President, Frederick Christensen, R. R. Howell & Co., Minneapolis; secretary-treasurer, C. E. Langdon, 3849 Lyndale avenue, south, Minneapolis. Meeting third Wednesday of each month at Athletic club.

Washington Foundrymen's Club

President, Rex L. Alexander, Olympic Steel Works, Seattle; secretary, Edward C. Gustin, 3716 Grayson street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.

Western Foundrymen's Association

President, H. T. Hornsby, Joplin, Mo.; secretary, E. L. Graham, Acme Foundry & Machine Co., Coffeyville, Kans.

Wisconsin Gray Iron Foundry Group

Secretary, W. F. Bornfleth, Cutler-Hammer Inc., Foundry Division, Milwaukee. Meetings on second Wednesday of each month at Hotel Schroeder, Milwaukee.

What Others Are Thinking

Abstracts Selected from European Foundry Literature

Heat Treat Cast Iron

Further Experiments on Oil Hardening and Air Hardening Cast Irons, by J. E. Hurst, *Foundry Trade Journal*, London, Dec. 3, 1931.

Amplification of a previous paper describing the results of some investigations into the properties of alloy cast irons of the nickel-chromium type, after hardening and tempering. The present investigation deals with plain cast iron made according to the centrifugal method. The results show the same characteristics as those disclosed with the alloy irons. Quenching with oil is accompanied by a sharp rise in the hardness value and a sharp drop in the ultimate strength. Tempering at increasing temperatures brings about a sharp recovery in the strength values. The maximum is attained at a temperature of 300 to 350 degrees Cent. (572 to 662 degrees Fahr.) The hardness values undergo a decrease which steepens sharply with the higher tempering temperatures. Maximum ultimate strength attained in each case exceeds substantially this value of the material in the *as cast* condition.

Studies Viscosity of Metals

Viscosity and Fluidity of Metals and Their Alloys (Viscosite et Coulabilite des Metaux et Alliages), by R. Berger, *La Fonderie Belge*, November, 1931.

The viscosity of various metals was investigated by three different types of apparatus which are described. Experiments show that viscosity decreases with temperature, and that the viscosity of an alloy can be found between the viscosity of its components for a given temperatue. Oberhoffer and Wimmer studied the viscosity of cast iron in 1924 and found that the viscosity remains constant as long as the metal is constituted by one phase. Appearance of crystals in the liquid phase increases viscosity. Viscosity is increased by carbon and by phosphorus. Sulphur decreases viscosity in the absence of manganese. Presence of sulphur with manganese increases the viscosity. Investigations on industrial cast irons were not conclusive, but seem to confirm the influence of manganese in the presence of sulphur. Thielman and Wimmer in 1927 experimented on cast iron at temperatures above that of the liquid phase, and found that when iron is superheated, viscosity decreases with temperature increase. Viscosity appears to be independent of chemical composition, but with constant temperature the viscosity decreases with the percentage of carbon; all the more rapidly when the temperature is lower.

Graphite Not Affected

The Influence of Mold Wall Condition upon the Formation and Quantity of Graphite Content in Gray Iron (Ueber den Einfluss der Formwandbeschaffenheit auf die Ausbildungsform und Menge des Graphitgehaltes im Grauguss), by H. Nipper and E. Piwowarsky, *Die Giesserei*, Dusseldorf, Germany, Jan. 8, 1932.

E. Scheil in 1927 reported that a piece of coal in a white iron caused the formation of long graphite crystals. The authors observed a similar occurrence with an iron soaked piece of coke which was thrown out the taphole of a blast furnace. To determine whether the thin blacking coating of molds had any effect on graphite formation, iron melted in a crucible in an oil fired furnace, superheated to various temperatures was poured at about 2534 degrees Fahr. into five similar molds. The molds contained cavities of 0.4; 0.79; 1.18 and 1.97 inches in diameter. The faces were coated with graphite, coke dust, soot, fireclay and coarse silica sand, and then dried. Chemical and metallographic examination showed that the coatings had no effect upon the formation or quantity of graphite. That was verified by the examination of two hollow rolls 18.5 inches outside diameter and 4 inches inside diameter whose walls therefore were 7.25 inches thick. One mold face was coated with graphite bearing blacking and the other with a silica wash.

Adopt Cast Iron Drums

Some Recent Developments in Automobile Cast Iron, by T. R. Twigger, *The Foundry Trade Journal*, London, Dec. 17, 1931.

Unquestionably cast iron is the most efficient brake drum material, but engineers are not in general agreement on the best method of application. For small drums a complete casting may be satisfactory. For large drums, especially those used on commercial vehicles, a steel or aluminum alloy drum with a cast iron liner machined from a centrifugal casting is a more satisfactory type. Where aluminum is used, the aluminum casing may be cast around the cast iron liner which is grooved to prevent the liner from rotating in service. The liners may be of austenitic cast iron which expands at a similar rate to aluminum.

The practice of pressing a centrifugal cast iron liner in to a worn steel drum is firmly established. The liner is machined about 0.010 to 0.015 inches greater in diameter than the steel drum and is riveted after it has been pressed into place. Usually the rivets are in two rows on a 3 or 3½-inch pitch. The riveting is a safety first measure adopted in the remote event that the pressed fit is insufficient to prevent the liner from rotating.

Drums treated in this manner show no signs of wear or cracking after 40,000 miles and there is no good reason for supposing that they should not give service up to 80,000 or 100,000 miles, a service far in advance of the life of any pressed steel drums.

Use Phosphorus in Brass

Deoxidizers and Fluxes, by G. L. Bailey, *Metal Industry*, London, England, Jan. 8, 1932.

The only satisfactory method of securing brass or bronze free from oxide by the addition of phosphorus is to deoxidize the copper before adding the zinc or tin. Oxide in brass or bronze is removed by the formation of a fluid phosphate slag containing tin or zinc as the metallic radicals. Phosphorus possesses one great advantage in that it appears to prevent, even in brass and bronze, oxidation of the surface of the stream in pouring. A suggested explanation of this phenomenon is that the volatile phosphorus is continually evolved from the metal and forms an envelop of reducing gas around the stream. To the author this explanation is not plausible. Phosphorus has a low boiling point, but so far as known it exists in solution in molten copper and in such small amounts that the partial pressure is extremely low. Furthermore, the loss of phosphorus on remelting a phosphor brass or bronze under reducing conditions is small and does not suggest any continuous evolution of this element. He suggests that the absence of an oxide skin on these materials in the molten condition is explained by the fact that such oxidation products as are formed are of the molten phosphate type, and not that surface oxidation is entirely inhibited.

Makes V-Guides for Machines

The Properties of Cast Iron for Good V-guides of Machine-tool Beds and Methods of Its Manufacture (Die Eigenschaften des Gusseisens guter Gleitbahnen von Werkzeugmaschininenbetten und Wege zu dessen Herstellung), by Rudolph Marker, *Die Giesserei*, Dusseldorf, Germany, Nov. 27, 1931.

V-guides for machine tool beds must possess the highest wear resistance and good machinability. To attain those properties the iron should have a pearlitic matrix without ferrite if possible; finely dispersed or eutectic graphite and only a little phosphorus. Such iron may be obtained in several ways. One method is by using charges low in silicon ranging from 1 to 1.3 per cent in the final iron; manganese from 0.8 to 1 per cent and phosphorus around 0.3 to 0.4 per cent. Another method is to use from 20 to 40 per cent steel or wrought iron scrap in the charges to produce low carbon iron. Chills may be used to provide a dense iron which is wear resisting and has a pearlitic structure. Additions of nickel and chromium produce a sorbitic matrix which undoubtedly has a higher wear resistance than the pearlitic matrix, but such additions seldom are made due to the price effect on those heavy castings.

The FOUNDRY Family Photograph Album

Upper Left

S. B. DAVIES

Royer Foundry & Machine Co.,
Wilkes Barre, Pa.

Upper Right

W. C. HAMILTON

American Steel Foundries
Indiana Harbor, Ind.

Lower Left

OLIVER SMALLEY

Gray Iron Institute
Cleveland

Lower Right

H. P. KREULEN

Spring City Foundry Co.,
Waukesha, Wis.

DAN M. AVEY
Editor

The Shakeout

FRANK G. STEINEBACH
Managing Editor

PAT DWYER
Engineering Editor

CHARLES VICKERS
Nonferrous Editor

EDWIN BREMER
Metallurgical Editor

¶ The New Monthly Publication

STARTING with the April issue, THE FOUNDRY will be published once a month instead of semi-monthly. The publication date will be the 15th. This decision of the publishers, as announced on the front cover of the February 15 issue, is made to better serve the interests of the entire foundry industry in the period of stabilization now at hand.

In effecting the change from a semi-monthly to a monthly basis, the March 1 and March 15 issues are consolidated in the current number, herewith. The subscription rate in the United States has been reduced from $3 to $2 a year and proportionate reductions applied to foreign rates. Subscribers at the old rate will receive an extension on their expiration date varied in accordance with the new lower price of the annual subscription.

WHEN the demands of the industry, largely along the lines of new construction and expansion of facilities, made necessary the change of THE FOUNDRY from a monthly to a semimonthly publication in April, 1919, the step was made in time with an accelerating expansion era. The time element was important and to serve all departments of the industry, embracing foundries, equipment, supply and material manufacturers, a shortened interval beween issue dates was desirable.

Now, in step with the demands of the reconstruction era in American industry and in recognition of marked changes in reading habits and needs, THE FOUNDRY again resumes publication on a once-a-month basis to serve better those same factors in the industry, the foundrymen and the manufacturers of equipment and supplies. Reading habits are changing. Greater study and a more careful search and use of printed information points to a new trend. Higher type material on business and technical subjects and careful selection is demanded.

THE FOUNDRY meets this situation by the change noted, which will permit certain contemplated improvements in character and quality of editorial material. The complete and detailed data on foundry practice which have given the paper its standing and authoritative character and sustained its reader interest through a period of almost forty years will be conserved. The intimate and friendly interest in the industry and every firm and individual identified with it, will be sustained. This defined and specialized service to the foundry world and the partisan promotion of every meritorious undertaking in its cause will be continued in the broader and deeper channels of the monthly publication. The judicious selection and treatment of editorial material of the highest value will be governed by considerations of the readers' interest in quality and in conservation of their time and effort.

THE monthly issue of THE FOUNDRY will be much larger than the semimonthly. Those features of vital importance to the foundry manager and operating executive will be continued and improved. The same careful attention will be given to business and technical trends bearing upon the industry and to the developments in mechanical and technical lines contributed by the engineering and equipment branches. Assistance and advice to the individual molder, coremaker, melter, machine operative, patternmaker and metallurgist, unique with THE FOUNDRY, and known to its readers as question and answer service, will be continued. The technical advisory staff, supplementing and checking the intimate and far-reaching knowledge of the active editors will be freely available to subscribers.

Just as THE FOUNDRY, in 1919, met the changed requirements of the foundry industry by developing the semimonthly issue, the change now at hand is induced by a similar sense of responsibility. Should future requirements make necessary or desirable a return to a more frequent publication schedule, THE FOUNDRY will be prompt to respond.

¶ The Biggest Handicap

IN OPEN-MINDED and unbiased considerations of the comparative merits of cast and fabricated products, castings are handicapped. That very ingenuity and ability of foundrymen to meet any sort of condition imposed by the engineering department has proved to be a liability instead of an asset. Engineers customarily consider the restrictions which standard rolled shapes and known physical properties of these shapes impose upon design. Nevertheless, they seldom take into consideration any negative factors of foundry technique, but blandly design a part for a machine without considering its foundry aspects and turn it over to the foundryman to make a satisfactory casting. Usually he does. But all interests would be served by more care in design of castings.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

SCOTT TURNER, director United States bureau of mines, Washington, was elected president of the American Institute of Mining and Metallurgical Engineers, New York, recently. Mr. Turner was graduated from the University of Michigan in 1904 with a degree of engineer of mines. Since then his professional work has taken him to all parts of the world, where he has served on the operating and consulting staffs of many well-known companies. At the

Photo Blank & Stoller
Scott Turner

outbreak of the World war, he was general manager of the Arctic Coal Co. in Spitzbergen. He negotiated the sale of the property to the Russian government, after narrowly escaping death when the LUSITANIA was sunk in 1915. When the United States entered the war, Mr. Turner served as a lieutenant in the navy. He was appointed chief engineer of the Mining Corp. of Canada after he was placed on the navy's reserve list in 1919 and in 1926 he was appointed director of the United States bureau of mines, succeeding Dr. H. Foster Bain.

Arthur H. Oberdorfer, advertising manager, Sivyer Steel Casting Co., Milwaukee, for the past 13 years, has resigned, effective March 1.

Thomas A. Elder, secretary of the Electric Steel Castings Co., Indianapolis, has been elected second vice president of the Associated Employers of Indianapolis.

C. C. Simpson, formerly foundry superintendent, Campbell-Hausfeld Co., Harrison, O., now is vice president, Standard Castings of Cincinnati Inc., Cincinnati.

Duncan T. Forbes, president, Gunite Foundries Corp., Rockford, Ill., will address the Quad City Foundrymen's association, Monday evening, March 21, on the subject of "High Test Iron."

W. J. Gibney recently was appointed vice president, Chemung Foundry Corp., 500 Erie street, Elmira, N. Y. The Chemung company also operates two foundries in Roselle Park, N. J.

Charles B. King, affiliated for the past 37 years with Marion Steam Shovel Co., Marion, O., has resigned his position as vice president of the company. He is president of the Ohio Manufacturers' association.

Edward N. Hurley Jr., president, Hurley Machine Co., Chicago has been elected president of the American Washing Machine Manufacturers' association, Chicago, for a third term.

J. S. Watson, vice president and general manager of the Indianapolis division of the Link-Belt Co., Chicago, was elected a director for three years to succeed George P. Torrence, who recently was transferred to Chicago.

Thomas S. Hammond, president of the Whiting Corp., Harvey, Ill., and vice president of the Illinois Manufacturers' association, headed a delegation of Chicago business and industrial leaders on a trip to Washington on Feb. 8 to plead for economy in government.

Dr. Harry P. Evans, chief metallurgist, Hubbard Steel Foundry division, Continental Roll & Steel Foundry Co., East Chicago, Ind., and formerly chief metallurgist, Pettibone Mulliken Co., Chicago, has been appointed chief metallurgist, Firestone Steel Products, Akron, O.

George Seiler, Lunkenheimer Co., Cincinnati, will be one of the speakers at the Cincinnati sectional meeting of the Ohio Foundries association on March 15. He will speak on "Accident Prevention" following a six o'clock dinner. The meeting, originally scheduled for Feb. 27, was postponed because of other activities.

Thomas W. Pangborn, president, Pangborn Corp., Hagerstown, Md., recently was elected chairman of the governing committee and executive vice president of the Hagerstown Bank & Trust Co. Mr. Pangborn also is a director of the Equitable Trust Co., Maryland-Virginia Joint Stock Land Bank and the Liberty Mutual Insurance Co., all of Baltimore.

Fred J. Blaney, for the past nine years superintendent, General Alloys Co., Boston, and formerly connected with the Driver Harris Co., Harrison, N. J., has resigned his position to take charge of the alloy division of the Ohio Steel Foundry Co., Springfield, O. Mr. Blaney comes from a family that has been connected with

Fred J. Blaney

the steel foundry industry for the past 50 years and received his training under the supervision of his father who was general manager of the Benjamin Atha Steel Castings Co., Newark, N. J. During his foundry experience he has been connected with considerable pioneer work in the making of heat resisting alloys.

Fred A. Moore, recently was appointed pattern supervisor, Washington Eljer Co., Los Angeles. Mr. Moore served his apprenticeship and was employed in a number of jobbing shops in Chicago. In 1919 he became connected with the Wolff Co. of Chicago as pattern maker, and eight years later was made foreman of the pattern shop.

Nelson W. Pickering was re-elected president of the Farrell-Birmingham Co. Inc., Ansonia, Conn., at the annual stockholders' meeting Feb. 18. **Franklin Farrell Jr.**, was re-elected chairman of the board, and **David R. Bowen**, Carl

Hitchcock, Franklin R. Hoadley and **Armin G. Kesseler** vice presidents All directors and other officers also were re-elected.

Harry W. Dietert, United States Radiator Corp., Detroit, is making a tour of the West Coast and giving talks before a number of foundry groups. In addition to the lectures on sand control and gating methods before the Washington Foundrymen's conference, at the university in Seattle on March 2, Mr. Dietert will speak before the Washington Foundrymen's club, a joint meeting of the Bay City and Pacific Coast Foundrymen's club, Stanford university, and the Los Angeles Foundrymen's club.

OBITUARY

John J. Toole, 79, former superintendent of the Union Steel Casting Co., Pittsburgh, now a part of the Blaw-Knox company, Blawnox, Pa., died Feb. 26 in Pittsburgh. Mr. Toole formerly was foreman of the Pittsburgh Steel Foundry Co. and later became superintendent of the Union Steel Casting Co., which position he held for 28 years until his retirement 10 years ago.

Emil Kluin, 81, head of a brass foundry bearing his name at Elizabeth, N. J., died at his home Feb. 7. He was a native of Germany and had been a foundryman for 40 years.

Charles B. DeLany, 67, superintendent, Columbus Brass Co., Columbus, O., died at his home recently after a brief illness. Mr. DeLany has been associated with the brass company for 35 years.

James D. Downing, 68, founder and first president of the Meadville Malleable Iron Co., Meadville, Pa., died at Washington Feb. 4. Mr. Downing had retired from active business about ten years ago.

Alexander Gallinger, 87, inventor of the automobile differential, died at his home at Oshkosh, Wis., Jan. 21. With the late John Morse, owner of an Oshkosh foundry, Mr. Gallinger in 1887 built a tractor which employed the differential principle.

John W. Galvin, for 38 years open hearth superintendent, Indiana Harbor works, Inland Steel Co., died at Long Beach, Calif., Feb. 17, following a traffic accident. Mr. Galvin was the father of John E. Galvin, president, Ohio Steel Foundry Co., Lima, O.

John H. Schaumleffel, one of the founders of the old Marion Grey Iron Foundry, now a unit of the Atlas Foundry Co., Marion, Ind., died recently at his home. Mr. Schaumleffel was born in Ohio in 1859 and went to Marion 38 years ago from Springfield, O.

John O. Horning, vice president and treasurer of the Mesta Machine Co., Pittsburgh, died Feb. 13 of pneumonia following an operation at Rochester, Minn. A resident of the Pittsburgh district practically all his life, Mr. Horning was also a director of the Mesta Machine Co. with which he had been affiliated for 40 years.

Charles T. Hildebrandt, plant engineer, Campbell Wyant & Cannon Foundry Co., Muskegon, Mich., died suddenly on Jan. 31. Mr. Hildebrandt entered the services of the Campbell Wyant & Cannon Foundry Co. 18 years ago and with the exception of an interval during the war when he served the U. S. shipping board in charge of one of the southern shipyards, the connection was continuous. He was a designer of special automatic machinery for various industrial purposes, as well as an engineer of ability and wide experience. Early in his career, he designed a single cylinder gasoline motor which was installed in a standard buggy body. The car was operated on the streets of Chicago and was contemporary with the pioneers in the automobile industry. Mr. Hildebrandt was 76 years old.

C. T. Hildebrandt

Warren A. Wilbur, 72, founder and chairman of the board of the Bethlehem Foundry & Machine Co., Bethlehem, Pa., died recently at his home. For many years, Mr. Wilbur has been identified with the leading industrial business interests of Bethlehem, being active in railroading and financial undertakings, as well as educational, philanthropic, social and civic affairs.

Frank Louis Schwarz Sr., president, Schwarz Foundry Co., 2001 West Ford street, Detroit, died at his home recently after an illness of 2 years. Mr. Schwarz was born in Detroit in 1860, and began his career with the Clough, Warren Organ Co. Later he was employed by the Russel Wheel & Foundry Co. for 25 years. He retired from the foundry business 8 years ago.

John Goodrich Osborne, 53, vice president of the Lakeside Malleable Castings Co., Racine, Wis., died Feb. 24. He was the son of the late William H. Osborne, who in 1870 established the Wisconsin Malleable Iron Co., Milwaukee, which discontinued business several years ago following a fire. Later he established the Lakeside company in Racine, which took over the Milwaukee concern's business upon its retirement.

Francis F. Light, 34, for the past few years circulation manager of *Steel*, died at his home in Cleveland, Feb. 19, following a brief illness. Except for the two years beginning in June of 1917, when he saw service overseas with the American Expeditionary Forces, Mr. Light was continuously associated with the Penton Publishing Co., Cleveland, publisher of THE FOUNDRY, *Steel*, *Daily Metal Trade*, and other trade and technical publications.

Ralph W. E. Hayes, 59, formerly president of the Hayes Pump & Planter Co., Galva, Ill., died Feb. 12 at Presbyterian hospital, Chicago. Mr. Hayes retired three years ago at the time of his election as president of the National Association of Farm Equipment Manufacturers, of which he was the head for one term. Mr. Hayes attended Northwestern and Michigan universities and then started as chief engineer for the farm equipment works, which was founded by his father, and which several years ago became a unit of Farm Tools, Inc., Evansville, Ind.

Employes Win Awards for Suggestions

A keener interest in learning to do their job a better way netted employes of the General Electric Co. a total of $55.739 during 1931. The annual suggestion report of the company, reveals that 19,595 suggestions were made by employes during the year, or an average of 428 suggestions for every 1000 employes.

Of the total number of suggestions submitted during the year, 6383 had sufficient merit to be adopted by the company, or an avrage of 139 for every thousand employes. During the year, 32.6 per cent of the recommendations were acted upon favorably, as compared to 32.1 per cent in 1930.

The highest amount paid for a suggestion during the year was $1000, which was awarded to an Erie, Pa., employe. The average award per adopted suggestion was $8.75. The high award for 1930 was also $1000, paid at the Schenectady works.

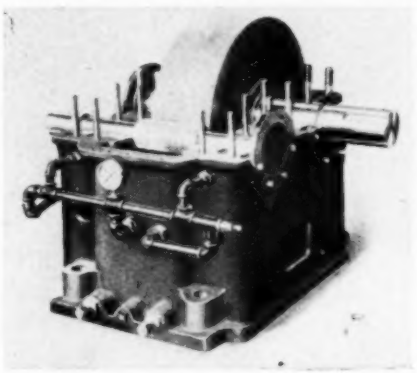
Develops Core Oil

E. F. Houghton & Co., Philadelphia, recently has developed a new mineral base core oil which it is claimed produces strong cores with a short baking time and a low baking temperature. It is also claimed that only a small amount of gas is produced when metal is poured against a core made with the new binder. Heat given up by the casting while cooling breaks down the binding strength of the core oil to such an extent that the cores may be cleaned from the castings. Since the core oil does not oxidize when exposed to the atmosphere, it is stated by the manufacturer that it can be mixed with sand and allowed to stand for several days without the sand hardening or requiring remelting for use.

Units Will Increase or Decrease Speed

Farrel-Birmingham Co. Inc., Buffalo, has developed and standardized a series of gear units suitable for speeds up to 6000 revolutions per minute and powers from 120 to 2500 horsepower, with ratios up to 10 to 1 for either increasing or reducing speed. A view of the unit with the cover removed is shown in the accompanying illustration.

The unit has a pair of herringbone gears with accurately generated con-



View with Cover Removed to Show Construction

tinuous teeth. The proportions of the gears, as regards the number of teeth, pitch, face width, diameter, depth of tooth, helical angle, proportions of addendum of pinion to addendum of wheel are chosen with special consideration as to whether the gears are to be used for increasing or decreasing speed.

The unit is provided with forced lubrication ball bearings and spray lubrication for the gears. The gears are not allowed to run in oil. The gear unit is self-contained, having its own lubrication pump, oil tank, cooler where necessary, and lubricating fittings consisting of pressure gage and relief valve. The oil pressure is between 10 and 15 pounds per square inch. The bearings are steel and bronze shells lined with babbitt. The gears, although of herringbone construction, are not allowed to have axial float. Rigidity of the mounting of the gears may be seen from the accompanying illustration. The shafts and bearings are made large to transmit power and minimize vibration.

Move Texas Offices

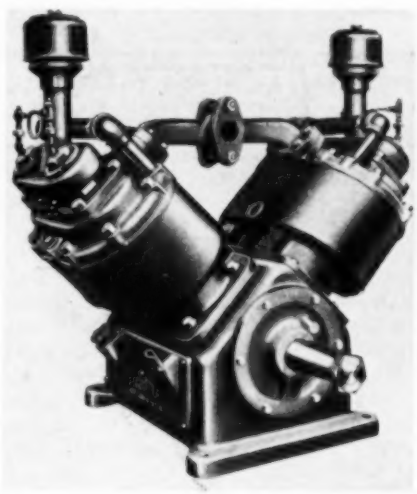
International-Stacey Corp., including the Roots-Connersville-Wilbraham division, the International Derrick & Equipment Co., Stacey Brothers Gas Construction Co. and Stacey Mfg. Co., has moved its Fort Worth offices to Room 307 Southland Life Insurance Co., Dallas, Texas. F. W. Mohler, midcontinent sales manager and C. B. Coldwell, sales engineer for the Stacey and Roots-Connersville-Wilbraham divisions and S. B. Creamer, sales engineer, International Derrick & Equipment Co., will be located in the Dallas office.

Compressors Are Built in Several Sizes

Curtis Pneumatic Machinery Co., St. Louis, has introduced on the market a new line of industrial compressors consisting of seven models, five of which are of the two cylinder type, ranging in size from 4¼ to 3¾ to 6½ x 5 with a displacement of 25 cubic feet to 125 cubic feet; and two of the four cylinder type, a 5½ x 5¼ and a 6½ x 5¼ size with a displacement of 115 to 262 cubic feet. The four-cylinder type is shown in the accompanying illustration.

The compressors are furnished not only as stationary units for belt drive from a line shaft, separate motor, steam engine or other prime mover, but they also are built as complete self-contained units either direct connected or driven by a V-belt. Features claimed for the compressors include carbon-free valves, the use of roller bearings on the crankshaft and a unique oiling method.

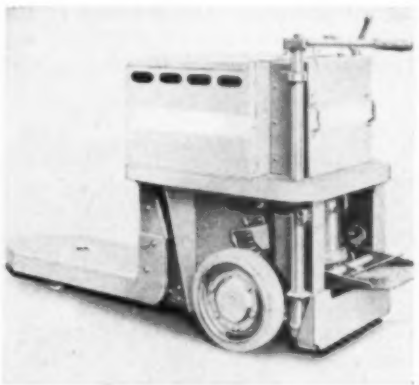
Valves are of the light disk type, double heat treated and made of rust-resisting metal. The head design of the compressor has made possible the carbon-free feature. This is accomplished by delivering air into the cylinder at the lowest possible temperature and maintaining the piston and cylinder walls at a minimum temperature. This low temperature is assured by having large diameter, short intake passages, large ports and straight line air flow. Carbon formation on the valves is further overcome in this construction because neither the crank shaft, counterweights nor connecting rods touch the bath of oil. A large steel oil ring is the only moving part of the lubrication system.



A Four Cylinder Type Industrial Air Compressor

Electric Trucks Operate in Small Spaces

Yale & Towne Mfg. Co., Philadelphia, has developed a line of small electric trucks having capacity rating of 3000 to 4000 pounds and suited to operation where floors or elevator capacities are limited, or where operating space is restricted. One of the trucks, a 3000-pound capacity low lift unit, is shown in the accompanying illustration. Other trucks of the line included a 3000-pound high lift type, 4000-pound capacity low and high lift



The Overall Width of the Small Electric Truck Is 29 Inches

trucks, high and low platform load carrying types and high lift fork truck.

The overall width of the trucks is 29 inches and the overall length of the high and low lift units with standard platform 42 inches long and with the operator's platform folded up is approximately 80 inches. The main drive controller used in these trucks has four speeds in either direction, which it is claimed, gives smooth, easy starting.

The controller interlocks with the driving brake, requiring the operator to turn the controller handle to neutral after releasing the brake, before driving power may again be obtained. The controller is arranged so that the operator can stop and start the load platform at any desired height. Top and bottom limit stops automatically cut off the power and apply the brake when the platform of the truck reaches the maximum position in either direction.

Buys Furnace Company

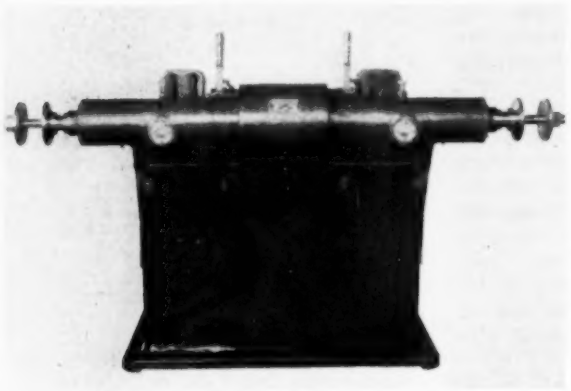
Foundry Equipment Co., Cleveland, has bought the business of the McCann-Harrison Co. and will operate it as a division, with main offices and plant at 1831 Columbus road, Cleveland. Foundry Equipment Co. produces core, mold and industrial ovens and McCann-Harrison Co. manufactures conveyor-hearth and standard furnaces for annealing, normalizing and heating.

Polishing Lathe Has Double Spindle

Hammond Machinery Builders Inc., Kalamazoo, Mich., recently has introduced a double spindle polishing and buffing lathe, as shown in the accompanying illustration. The tool is designed for the use of either two 3, two 5, two 7½ or two 10 horsepower motors.

The design of the machine incorporates overhanging spindles so that maximum working clearance is afforded at all times. Each spindle has its own motor, starter, multiple-V belt, switch and brake, and each spindle can be operated independently of the other. It is pointed out that the tool is efficient on work where two different speeds are necessary on one operation. A screw feed slide rail on the rear of the pedestal is provided for belt tension adjustment.

The machine is supplied with the Hammond company's standard oiling system or with a cascade oiling system, consisting of an oil pump which is driven by a worm gear and worm, the latter cut on the spindle. From the oil pump the oil is forced through a filter. From the filter there is a continuous passage to a larger reservoir. It is pointed out that this oiling system is an assurance of clean oil and of the oil's passing through the bearings under pressure. A glass front oil-level gage and pressure indicator is provided as a part of the oiling system.



The Design of the Lathe Incorporates Overhanging Spindles To Afford Leg Room for the Operators

New England Founders Discuss Costs

The regular monthly meeting of the New England Foundrymen's association was held at the Engineer's club, Boston, on Feb. 10, with President LeRoy M. Sherwin presiding.

E. H. Ballard, General Electric Co., and president of the American Foundrymen's association, addressed the meeting. Mr. Ballard spoke on the present foundry situation and the manner in which the New England Foundrymen's association could be of greatest benefit to its members. He concluded his remarks with a discussion of costs. Charles A. Klaus, Gray Iron institute, Newark, also discussed the subject of costs.

Shows Installation of Handling Equipment

Installation of sand handling equipment at the Spring City Foundry Co., Waukesha, Wis., was shown in moving pictures by F. A. Pampel, Chain Belt Co., Milwaukee, at the regular meeting of the Wisconsin Gray Iron Foundry group held Feb. 10 at the Hotel Schroeder, Milwaukee.

H. P. Kreulen, Spring City Foundry Co., led the discussion which followed the showing of a second film illustrating modern installation of cupolas and material handling equipment at his foundry.

Professor R. S. McCaffery, University of Wisconsin, Madison, Wis., presided at the meeting.

Foundrymen Hear Talk

Leonard Dreyfus, president, United Advertising Corp., New York, addressed the regular monthly meeting of the New Jersey Foundrymen's association on Wednesday, Jan. 27, at the Downtown club, Newark. The subject of the address was "Looking Ahead."

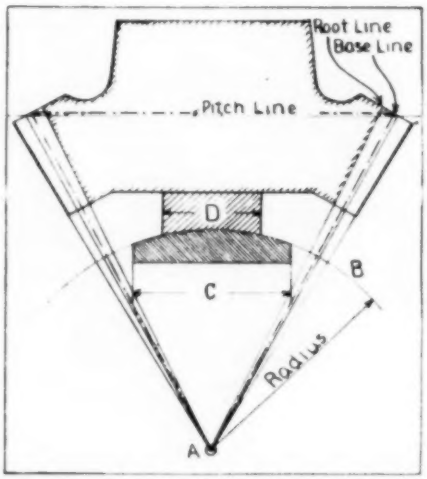


Fig. 1—Base Lines Lead to Center

Bevel Gear Teeth Cut on Band Saw

By Herman Schneider

Accompanying illustrations show how the teeth on a bevel or miter gear may be cut accurately on a band saw provided usual precautions are observed properly. In a bevel gear all the basic lines run to a common vertex. Assuming that a pattern blank for a pinion has been turned as shown in Fig. 1 and a convenient radius *A B* chosen for the operating circle. A block *C*, 12 inches or more in diameter is turned in the lathe so that the upper or working face conforms to the radius *A B*. The diameter of the block will vary in accordance with the diameter of the gear pattern on which the teeth are to be cut. The intermediate block *D* then is prepared. It may be a separate block or it may be turned directly on the gear pattern blank. The under face of this block is turned concave so that it fits exactly on the upper face of the block *C* in a general ball and socket style. The height or thickness of the block *D* must be regulated according to the bevel on the teeth.

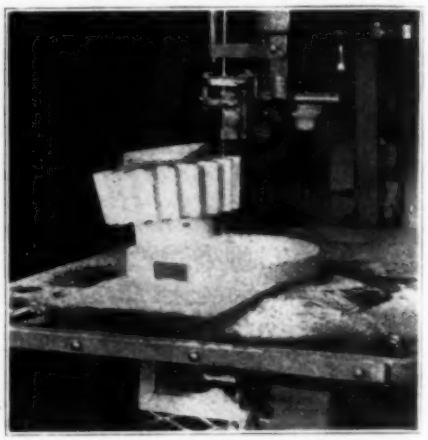


Fig. 2—Two Blocks Working on Ball and Socket Joint Hold the Gear Blank in Alignment

The block *C* then is clamped to the saw table in such a manner that the points of the saw teeth pass the exact center as shown in Fig. 2. Assuming that the outline of the teeth has been laid out on the pitch line of the pattern blank before the blank was taken to the saw, the block now is ready for sawing. A tooth root line marked on the inside of the gear blank will serve as a guide and check and show whether or not the saw is running accurately.

W. C. Lytle, Evanston, Ill., has terminated his connection with the Pangborn Corp., with which organization he was active for 16 years, and during the past 10 years was district sales engineer for that firm in Chicago.

A.I.M.E. Holds Meeting in New York

Asserting that the great industrial problem of today and of the future is to develop additional markets and to regulate production to demand, Robert E. Tally, retiring president of the American Institute of Mining and Metallurgical Engineers, stressed particularly the need for co-operative action on the part of individual members of an industry.

The meeting held Feb. 15-18 in New York, was attended by 1500. The Robert W. Hunt prize was awarded to Howard Scott, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. and Ora E. Clark, Hamilton Coke & Iron Co., Hamilton, O., received the J. E. Johnson Jr. award.

Scott Turner, director of the bureau of mines, Washington, was elected president. Newly elected vice presidents are H. N. Eavenson, Pittsburgh, and H. A. Guess, American Smelting & Refining Co., New York.

A new feature this year was a symposium on gases in metals. The diverse ways in which gases affect the properties of both molten and solid metals came in for special investigation, and the nine papers presented were, in a broad sense, in the nature of reports.

Discussing certain effects of temperature and iron oxide in the manufacture of basic open-hearth steel, W. J. Reagan, Edgewater Steel Co., Oakmont, Pa., declared that the percentage of iron oxide in the metal is in proportion to the iron oxide of the slag, and can be controlled by proper melting and working conditions. Fast melting and slow working or refining, he said, keep the iron oxide at a minimum. Automatic furnace control that will actually control furnace atmosphere, and also combustion conditions, will be a long step toward control of iron oxide and open-hearth rejections, Mr. Reagan concluded.

Wilhelm Rohn, Heraeus Vacuumschemlze, A. G., Hanau, Germany, observed that the technique of vacuum melting has been developed far enough to be introduced now for special purposes. To start the melting in a vacuum furnace with cold charges would be too expensive, he declared; however, he thought there would be advantages in starting such furnaces with molten metal, so as to carry out the refining processes by the vacuum melting method.

Determination of oxygen, nitrogen and hydrogen in steel was discussed by J. G. Thompson, metallurgist, bureau of standards, Washington. The effect of inclusions and their solubility and control in cast steel were discussed by C. E. Sims and G. A. Lillieqvist, research metallurgists, American Steel Foundries, Indiana Harbor, Ind. It was concluded that a direct relationship exists between the character and distribution of inclusions in cast steel and the ductility of such steels; also, that the globular type of inclusion scattered haphazardly through the steel has the minimum effect on the physical properties.

N. A. Ziegler, Westinghouse Electric & Mfg. Co., East Pittsburgh, discussed resistance of iron-aluminum alloys to oxidation at high temperatures and stated that at 4 per cent aluminum the improvement becomes appreciable in its resistance and alloys at 6 per cent aluminum appear only slightly inferior to nickel-chromium alloy.

Detroit, the Scene of the 1932 Convention of the A. F. A., Presents an Impressive Night Picture

Impact strength of die-cast zinc-base alloy varies with temperature, the alloy being brittle at low temperatures, toughening as it rises and reaching a maximum somewhere below the critical temperature of decomposition of the beta phase, according to Bert E. Sandell, Stewart Die Casting Corp., Chicago. Two alloys were used in the tests showing the effect of temperature upon the carpy impact strength of die-casting alloys. Those used were zinc-base and aluminum-base alloys. In two die-cast aluminum-silicon alloys no appreciable variation was noted in impact strength from zero to 500 degrees Fahr.

Study Volume Changes

The January issue of the bureau of standards' *Journal of Research* contains an article by C. M. Saeger Jr. and E. J. Ash describing the investigation work carried on for a method of determining volume changes occurring in metals during casting. In cooperation with the American Foundrymen's association work was begun at the bureau in 1928. Curves of specific volume-temperature were obtained by filling a crucible of known volume with liquid metal at a known temperature. Solid contraction of the metals also were determined, and data on both investigations are presented in the article.

Book Review

Chevrolet Six, Car and Truck, by Victor W. Page, cloth, 5 x 7½ inches, 489 pages, published by the Norman W. Henley Publishing Co., New York, and supplied by THE FOUNDRY, Cleveland, for $2 plus 15 cents postage, and in England by the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster.

Owners of Chevrolet trucks and passenger cars will be interested in this handy reference book which describes the construction, operation and repair of those automobiles. The first chapter deals with general construction features, and Chapter II with the engine, its operation and construction. The fuel and carburetion system is described in Chapter III, and Chapters IV and V relate to the engine lubrication and cooling system. Chapter VI covers the starting, lighting and ignition systems while Chapter VII contains operating instructions for drivers. Car lubrication and maintenance is described in Chapter VIII. Chapter IX is on tools, shop practice and notes for mechanics; Chapter X covers engine top overhaul and Chapter XI describes major engine overhaul. The remaining chapters deal with overhauling clutch and transmission, rear axle and driving gears, front and rear brakes, front axle and steering systems, and body service, inspection and repair. The final chapter contains question and answers for review. Each chapter describes in detail the various parts and operations, and contain many illustrations which amplify the text matter.

Is Made Chief Engineer

W. A. Rosenberger recently was appointed chief engineer, Pangborn Corp., Hagerstown, Md., manufacturers of blast cleaning and dust collecting equipment. Mr. Rosenberger, a native of Switzerland, graduated in 1909 from Polytechnikum at Zurich and later came to the United States. For the past 20 years, he has specialized in blast cleaning and dust collecting problems.

What the Foundries Are Doing

Reflecting the Activities of Gray Iron, Malleable, Steel and Brass Shops

Philbrick-Booth & Spencer Inc., 367 Homestead avenue, Hartford, Conn., was slightly damaged by fire recently.

American Steel Foundries, Alliance, O., resumed operations recently, re-employing approximately 600 men.

Decatur Malleable Iron Co., Decatur, Ill., is being closed and the equipment consolidated with the Danville Malleable Iron division of the Allith-Prouty Co., Danville, Ill.

Lake Shore Pattern Works Inc., Chicago, has been incorporated with $20,000 capital to manufacture metal specialties, by Gustave A. Andres, 3813 Ravenswood avenue.

Filer & Stowell Co., 219 East Becher street, Milwaukee, has awarded a contract for an addition, 63 x 168 feet, to its foundry. James L. Monaghan is president and general manager.

Hurwich Iron Co. Inc., South Bend, Ind., has been incorporated with 6000 shares no par value to forge and cast metal, by Maurice L. Hurwich and associates.

Athens Stove Works, Athens, Tenn., is constructing an addition, 125 x 200 feet, to cost about $20,000. Nicholson Construction Co., 102 West Clinch avenue, Knoxville, Tenn., is contractor.

Maytag Co., Newton, Iowa, power washing machines, is operating more than 75 per cent, approximately the same schedule that has prevailed at the company's plant since the middle of October.

Doehler Die Casting Co., Toledo, O., recently added 350 workers to its plant, representing an increase of 100 per cent. In February the company was operating its Toledo plant at 75 per cent of capacity.

Barberton Foundry Co., Barberton, O., a subsidiary of the Akron Standard Mold Co., Akron, O., has been working full time schedule six days a week on semisteel molds for the new type of doughnut tires recently introduced.

New Orleans Car Wheel Co., New Orleans, has established a plant at Southport, a suburb of New Orleans, for manufacture of car wheels and railroad rolling stock. J. B. James is president and general manager, and George Q. Green is plant superintendent.

Wellman Bronze & Aluminum Co., Cleveland, has been licensed by Dow Chemical Co., Midland, Mich., to produce sand castings of Dowmetal, magnesium alloy manufactured by the latter firm. The metal is adaptable particularly where lightness is an important factor.

Medina Iron & Brass Co., Medina, N. Y., manufacturers of cast iron pipe and fittings, recently reorganized, plans expansion with facilities for production of other iron and brass products. The company has been identified with the Summerville Iron Works, Summerville, N. J.; William J. Kirby, one of the heads of the Summerville Co., is president-chairman of the board of that organization.

Mid-February foundry production schedules in the Chicago area showed virtually no change. Several railroad equipment foundries became active on a light scale. Aluminum foundries continued at relatively better schedules than in other nonferrous shops, due to some automotive and also kitchen utensil business.

Sorel Steel Foundries Ltd., Sorel, Que., has been formed as the successor of Beauchemin & Fils, a subsidiary of Consolidated Marine Companies Ltd. The equipment will be modernized and new lines will be added. P. H. Desrosiers, formerly managing director of the Joliette Steel Ltd., has been made general manager.

Pressure Pipe Co. of Canada Ltd. has obtained a site of seven acres at Vancouver, B. C., on which it plans to build a pipe manufacturing plant to cost $75,000. Company is controlled by Canada Iron Foundries Ltd. and Consolidated Pipe Co., Montreal, Que., has $500,000 capital. First production will be pipe for the First Narrows tunnel, a large type.

Williams, White & Co., Moline, Ill., manufacturer of machinery, castings and forgings, has bought the assets and goodwill of the Rock River Engineering Works, Janesville, Wis., manufacturer of bending rolls, hydraulic straightening presses and hydraulic molding presses. G. H. Case, former owner and manager, will be associated with the purchasing company.

Globe American Corp., Macomb, Ill., is transferring its foundry to Kokomo, Ind. The Macomb plant will not be closed but foundry work will be concentrated at Kokomo. The company manufactures stoves, ranges, brooders and other types of heaters. W. Dow Harvey, Kokomo, is president.

RAW MATERIAL PRICES

March 1, 1932

Iron	
No. 2 foundry, Valley	$15.00
No. 2 Southern, Birmingham	11.00
No. 2 foundry, Chicago	16.50
No. 2 foundry, Buffalo	16.00
Basic, Valley	15.00
Basic, Buffalo	15.50 to 16.00
Malleable, Chicago	16.50
Malleable, Buffalo	16.50
Coke	
Connellsville Beehive Coke	$3.25 to 4.50
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	8.00
Scrap	
Heavy melting steel, Valley	$9.00 to $9.50
Heavy melting steel, Pitts.	10.00 to 10.50
Heavy melting steel, Chicago	6.75 to 7.25
Stove plate, Buffalo	8.25 to 8.75
Stove plate, Chicago	5.75 to 6.25
No. 1 cast, New York	6.50 to 7.00
No. 1 cast, Chicago	8.00 to 8.50
No. 1 cast, Philadelphia	10.50 to 11.50
No. 1 cast, Pittsburgh	9.50 to 10.00
No. 1 cast, Birmingham	8.00 to 9.00
Car wheels, iron, Pittsburgh	10.00 to 10.50
Car wheels, iron, Chicago	7.00 to 7.50
Railroad malleable, Chicago	6.75 to 7.25
Agricultural mal., Chicago	6.50 to 7.00
Malleable, Buffalo	9.50 to 10.00
Nonferrous Metals	**Cents per pound**
Casting copper, refinery	5.75 to 6.00
Straits tin	22.05
Aluminum, No. 12, producers	22.00
Aluminum, No. 12 remelt	8.50 to 9.00
Lead, New York	3.50
Antimony, New York	6.25 to 6.37½
Nickel, electro	35.00
Zinc, East St. Louis, Ill.	3.80

Trade Publications

MAGNETIC SEPARATORS—Magnetic Mfg. Co., Milwaukee, in Bulletin No. 10 describes its type K induction magnetic separators, with illustrations, description and specifications of various sizes.

ALUMINUM ALLOYS—The National Smelting Co., Cleveland, recently has published a bulletin on the corrosion of aluminum alloys which presents information on electrolytic corrosion and preventative methods.

STEEL CASTINGS—National-Erie Corp., Erie, Pa., in a current leaflet gives engineering data on its heat-treated and hardened gears and its alloy steel castings. A page is devoted to description of facilities available to patrons of the foundry.

TRACTORS—Caterpillar Tractor Co., Peoria, Ill., has issued a circular largely of halftones, showing many uses to which its tractors have been put and suggesting that many more places probably exist where this power unit can be utilized economically.

ELECTROTINNING—The Roessler & Hasslacher Chemical Co., New York, has published a 12-page bulletin giving information on its sodium stannate-acetate plating bath for tin plating. Data is given on the bath composition, operating conditions, control and maintenance, and cleaning prior to plating.

CASTINGS—Indianapolis division of Link-Belt Co., Chicago, is distributing a book devoted to Promal castings, a metal originally developed for Link-Belt Co.'s own use in the manufacture of conveying and power transmitting chains. The book shows the applications of the metal for other purposes than chain, and gives a comprehensive description of its qualities and technical data concerning it.

RUST INHIBITER—The Skybryte Co., Cleveland, has published a folder describing its corrosion inhibiter. It is claimed that the material renders rust on iron and steel chemically inactive, and that it resists heat up to 550 degrees Fahr. and acid fumes, smoke, salt air, and oxygen. The compound is brushed or sprayed on, and is said to be an excellent vehicle for aluminum flakes, red lead and graphite.